A SUMMARY OF OUR KNOWLEDGE OF OREGON'S IGNEOUS GEOLOGY

by

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INTRODUCTION

This thesis deals with two problems, herein called parts (1) and (2); both of which deal with Oregon's igneous rocks but otherwise are not related.

Part one consists of a summary of all available literature on the subject of igneous geology in Oregon. It seemed desirable to make this summary for a number of reasons. Investigations on the important volcanic province found in the state of Oregon have been carried on by various workers in the field since about 1869. As a result considerable data pertaining to the igneous rocks are available in numerous publications. But the investigator interested only in reviewing igneous material, will find its segregation from the associated literature a lengthy process. A summary would then serve to make this literature more easily available and would facilitate the correlation of field data gathered in the future with the literature.

In addition it often develops, when working on a complex and many-sided problem, that when certain facts are brought out into the light and placed side by side that relations, and insight into underlying principles, become apparent which otherwise might remain forever obscure.

The belief is widespread that Oregon's greatest ore deposits remain yet to be discovered. That this opinion is not entirely unfounded is evident for a number of reasons.

First, no source of valuable metals comparable in magnitude to the widespread placer deposits has yet been located. Secondly, the prospector has been severely handicapped because of the fact that the most likely areas in Oregon are either covered with recent lavas or heavy vegetation or both. It is quite reasonable to believe that deposits exist that do not outcrop and have, to date, escaped discovery and that they will continue to do so as long as present methods are pursued. Mineral production figures have been steadily declining indicating that as a general rule the known deposits of ore are not persisting in depth. Men who are probably the best informed now agree that the best approach to the problem will be through the medium of geological investigation. Geological research into the relations of petrology to modes of ore deposition should be the first step. In the future it is hoped that geological investigation will be allowed to advance to the point whereby the prospector can be guided to certain small select areas upon which he can spend his energies going over such areas, figuratively speaking, "with a fine tooth comb". If this were to come to pass, these select areas could be literally perforated with drill holes with the money that has here-to-fore been largely consumed in machinery foredoomed to lie idle.

It is the hope and intention of the writer that this compilation of selected extractions from the literature will serve as a preliminary step however small, toward the ultimate goal contemplated above.

Throughout this review, in order best to serve the above outlined purposes, considerable detail has been given to papers dealing with the petrography, petrology, chemistry, and structure of the igneous rocks while papers dealing chiefly with the occurrences of common and well known formations have merely been mentioned in passing.

The following method of survey was used. First all publications referred to in existing bibliographies, (1), (2), were examined for their treatment of igneous rocks strictly related material. This material has been listed using the author's name as the index base. Statements have been transcribed verbatum provided they contained definite information and were of sufficient brevity. So far as they were available, the author's own abstracts and summaries have been quoted. In other cases summaries have been made by the writer. In regard to certain papers, the length and nature of which made a satisfactory contraction impracticable, a mere statement of their content has been made.

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(1). Dixon, Dorothy, E. Bibliography of the Geology of Oregon. University of Oregon Pub. (1926) Geol. Series V. 11, No. 1

(2). Hodge, E. T. Progress in Oregon Geology Since 1925. University of Oregon Publication (1931)

In order to lend greater utility to the compilation referred to above a rock species index and locality index have been made and are placed in the appendix.

While this summary makes no pretense to being entirely complete, it does cover the majority of the important papers.

The review of the literature has been summarized in tabulated form (Table I) and appears at the end of section I. Here all like rock species mentioned in the literature have been grouped together in alphabetical order with the reference number, locality, and authority.

Part II is devoted to a study of certain selected suite of igneous rocks from the northern Cascade Mountains of Oregon in comparison with a collection of rocks from world famous localities which have been studied by such well known authorities as Krantz, Harker, and Tomlinson. The purpose in making this study was to determine if possible the nature of the differences between the northern Cascade rocks and those rocks from comparable igneous provinces.

The Cascade Rocks examined represent several hundred specimens, collected over a period of about 10 years by men working on research problems in the Cascade Mountains under Dr. E. T. Hodge. This collection has been previously classified by workers and divided into various types. These rocks probably represent the most complete collection of Cascade rocks in existence in any laboratory.

The foreign igneous rocks against which the above were compared represent the combined collections on file in the petrography laboratory developed through a period of years at the University of Oregon and at Oregon State College.

A megascopical examination was first made of these two large groups of rocks. And those that appeared to be similar in regard to texture and mineral constituent were placed together. Of the several hundred rocks examined in the above manner about forty appeared to be identical, or so nearly so, as to warrant further investigation. This number was then appreciably cut down by an examination with the aid of a hand lens. Those that were finally found to be comparable were given a complete microscopical examination. Thin sections of these rocks that were not already available were prepared by the writer. Table II, page 132 is a list of those rocks by number that with their apparent counterparts were subjected to the microscopical examination.

Introductory Summary of Part II

The following conclusions have been entered here instead of at the end of the text because it seemed desirable in a paper of this kind to keep all discussion matter in one section where it can more easily be found.

As the work of microscopic comparison progressed, it became apparent that considerable variation existed between the rocks that megascopically had appeared to match each other. In thin section, each rock appeared entirely different from the other it was supposed to match. For the most part the members of each pair contained several minerals in common. Also, several minerals were generally contained in one rock that were not to be found in the other. For instance, one would contain hornblende and hypersthene and the other augite and olivine. In other words, no consistent variation could be discovered among the group of rocks studied. The variation between individual pairs, however, was sometimes great, both in regard to mineral constituents and percentages present. Only in the case of thin sections No. As 796 and T: 10:16 could the two rocks be considered entirely comparable and in this case, close agreement would be expected as the latter rock is from Hood River, Oregon, and not a foreign type. Of the other rocks, Nos. 0-611 and T: 10:11 come the nearest to agreement but in the opinion of the writer even these cannot be considered equivalent. As a result of this study, the writer does not wish to make a sweeping statement to the effect that all Oregon rocks are entirely different from all rocks of other volcanic provinces, but merely that the method used did not disclose any persistent similarities. It seems probable, however, that if all available thin sections were compared to a large number of sections selected from world famous localities that certain identities would be found. It would then be of interest to compare the hand specimens of these sections. The noted differences seen in thin sections of rocks that in hand specimens appeared nearly identical, as shown in this study, indicate that it is not safe to brand a rock, picked up in a certain volcanic field, as being the same as a rock from another field, however similar their outward appearance may be. This is ordinarily possible within the same volcanic formation where differentiation is known to be lacking.

Color cannot be relied upon as the sole determining factor in the decision as to whether two rock species are identical as the differential weathering of some minor constituent may materially affect the color. In general it was found in this work that a combination of texture, luster, color and evident minerals sufficed for the preliminary megascopic comparison.

Comparative tables of chemical analyses show the Cascade rocks to differ but little chemically from similar rocks of other volcanic fields of the neighboring Pacific region. This fact would seem to indicate that these rocks originated from a similar source magma, or melt. It is therefore probable that the variance observed is due chiefly to mineral differentiation. Questions naturally arise as to the cause of this differentiation. It may have been that the lavas of this region extruded and solidified under physical conditions slightly different than existed in contemporary fields. It has been demonstrated beyond doubt that magmas solidifying under varying physical conditions undergo differentiation. Modifying factors are pressure of overburden or solidified crust, temperature, and rate of extrusion and cooling. Possibly the original magmas were not so nearly alike as analyses of the end products, the solidified rocks, would seem to indicate. In particular the extent to which volatile constituents may have escaped from either magma is not known. Possibly, too, a true sample was not obtained of the rocks under consideration and that an exaggerated mineralogical variation resulted. The law of averages, however, minimizes this possibility. If the indicated variation is typical or truly representative, the investigation of the causal factors will be an interesting problem for the future.

The extent of the variations in chemical composition of rocks from the Cascade Mountains and from neighboring volcanic fields is shown graphically in Figs. a - 3b, page 120 "Variation diagrams" after Howell Williams[1].

Williams, Howell Newberry Volcano of Central Oregon. B.G.S.A. Vol. 46 No. 2, Feb. 1935.

SECTION I

REVIEW OF LITERATURE

Allen, J. E. Contributions to the Structure, Stratigraphy and Petrography of the Lower Columbia River Gorge. University of Oregon, Thesis 1932.

1 (Content)

A discussion of the various formations of the lower Columbia River gorge.

"The igneous rocks are divided into four types. Below are listed a few of the more outstanding charistics of the various types.

I. 1. Large amount of total plagioclase, above 75%

2. Dominance of andesine.

3. Lack of glass, olivine, orthoclase, quartz.

4. Light color, porphyritic texture.

II. 1. Total plagioclase range between 40% and 60%.

2. Porphyritic, intersertial, most common.

3. Presence of pyroxene, magnetite, glass.

4. Absence of quartz, olivine.

5. Color very dark.

III. 1. Light grey color.

2. Absence of glass, quartz, olivine.

3. Presence of hypersthene.

Microscopically, these rocks are not distinguishable from type II, showing difficulty in classifying rocks by their outward appearance. In hand specimens these are grey andesites, while type II rocks are black vitrophyres and and basalts. There are few rocks placed in II, however, that may be correlated with the Cascade andesite type by the presence of hypersthene, if this mineral can be used as a distinguishing diagnostic. They are as follows:

II Ac	rock 649
II Ad	rock 585
II Db	rock 324
II Eb	rock 587

IV. 1. Olivine phenocrysts.

2. Speckled light grey color.

3. Absence of quartz, glass.

Petrographic Percentage Summary:

1	2	3	4	5	6	7	8	9	10	11	12	13
I A.	560	3		73	12	85		15	Tr			Andesine porphyry
	545		60		15	75		4	3			Andesine porphyry
	548		10	43	40	93	1	1	2	3	13	Andesine porphyry
B.	806	25				25	20	30	4	20	Tr	pyroxene trachyte
II A.	354'		10		15	25	4	13	5	50		trachyte andesite
	354"				56	56		11	4	25		basalt vitrophyre
	617			67		67		20	8		5	andesine porphyry
	596	12				12	8	2		80		trachyte vitrophyre
	998	6	20	11		37		10	3	50		andesine vitrophyre
	603	18			16	34		2	32	32		basalt porphyry
	800	5		10		15		10		70	5	andesine vitrophyre
	649		50			50		32	15			pyroxene andesite
	585	8	40		15	63		4	12	20	Tr	andesine porphyry
	650				15	15			20	65		basalt vitrophyre
	559		20		45	65		15	10	5	Tr	basalt porphyry
	1024	30			10	40		10	5	40	5	trachytic andesite
B.	823				50	60		20	5		20	augite phite
	824			7	60	67			7	25		basalt vitrophyre
	857			4	8	31	65	15	6		2	trachytic andesite
C.	553			40	30	70		15	15		Tr	trachitic basalt
	652				40	40	15		15	20	7	basalt porphyry
	825				50	60		15	10	10	5	hornblende diabase
D.	638		6			6			32	60		andesine vitrophyre
	324			24		24	20	6	2	45	3	andesine vitrophyre
	656		25			25		25	15	5	30	augite vitrophyre
E.	322			38	5	43	30	5	2	15	3	andesine porphyry
	537			68		73	5	19	8			augite andesite
	602			20	35	65	10	20	10		6	augite basalt
III	652b81			4		4						andesite
	817		40	12	30	82		13	5			andesite
IV	341			40	5	45	15	20	4	10	3	olivine andesite
	600	40				65	25	21	7	4		olivine andesite
	653			70		70		15	6	8	1	olivine andesite
	882		60		20	80	12	9	1			olivine andesite

References for columns of the above petrographic summary:

1. Rock type
2. Rock number
3. Oligoclase percentage
4. Oligoclase-andesine percentage
5. Andesine percentage
6. Labradorite percentage
7. Total plagioclase percentage
8. Other feldspars percentage
9. Pyriboles percentage
10. Magnetite percentage
11. Glass percentage
12. Secondary mineral percentage
13. Assigned name of rock "

Anderson, Frank M. Cretaceous Beds of the Rogue River Valley
Jour. Geology 3:455-468, 1895

2 (Content)

"...near Talent basaltic hills form the western edge of the Cascades...They consist of old basalts, andesites and other basic eruptions...pre-chico in age."

Anderson, Frank M. Neocene Basins of the Klamath Mountains.
Bull. Geol. Soc. America 12:500-1, 1901

3 (Content)

"...Lava flows from the Cascades diverted damage from the Klamath lakes basin from the Rogue River to the Sacramento."

Anderson, Frank M. Physiographic Features of the Klamath Mountains. Jour. Geology 10:144-59, 1902

4 (Content)

Contains notes and estimations of the duration of volcanic activity in southern Oregon.

Anderson, Frank M. Physiography and Geology of the Siskiyou Range. Jour. Geology 11:100 1903

5 (Content)

"The igneous rocks range from ultra basic to acid types and are mainly deep seated.....Magmatic differentiation in the plutonic rocks is extreme. The granitic rock passing by gradiations into diorites, gabbros, and other pyroxene bearing rocks."

Further notes on their modes of occurrence.

Austin, W. L. The Nickel Deposits Near Riddles, Oregon. Proc. Colorado Sci. Soc., Jan. 1896

6 (Content)

Includes an account of the location of the deposits, their method of occurrence, the development work, the probable origin of the ores, and the metallurgy of the ores, discussing them fully.

The theory of deposition by ascending thermal waters is advanced.

Barnes, F. F. and Butler, J. W. The Structure and Stratigraphy of the Columbia River gorge and Cascade Mountains in the Vicinity of Mt. Hood. Univ. of Oregon, Thesis 1930

7 (Content)

A discussion of the physiography, stratigraphy structure and related problems of the Columbia gorge region.

Describes the occurrence and extent of the Columbia River basalt and Cascade andesites with age relationships, etc.

Bogue, R. G. A Petrographic Study of the Mount Hood and Columbia River Basalt Formations. University
8 of Oregon Thesis. 1932

Part I, Summary of Mount Hood andesites:

"These lavas are essentially all of one main type with only minor variations within the limits of the group. In the main, the principal variation is in the composition of the plagioclase feldspars. There is a general gradation of the more sodic varieties found at the lower elevations to the more calcic near the top of the mountain. This is not a continuous gradation and there are many rocks at various elevations which depart from a perfect gradational series. Labradorite is usually found at the higher elevations. This general relationship can be seen by an inspection of the charts which are included above.

All of the rocks contain hypersthene in varying quantities and those of the higher elevations usually have a greater percentage of this mineral than those found at lower elevations. This statement as in the case of the plagioclase feldspars must be made with reservations as there are numerous exceptions.

Hornblende is not found in all the rocks but is a constituent in the majority. The same is true of this mineral as of the hypersthene and with the same numerous exceptions that the percentage present increases with an increase of elevation.

Magnetite is present in all the thin-sections but in a minor quantity. Perhaps this should be classed as an accessory mineral but it is not considered so with its persistent occurrence in these rocks.

Augite is present only in minor quantities and in many cases its presence is doubtful. It is of minor importance when the small quantity and minute size of the crystals are considered.

Apatite occurs only as inclusions in the larger phenocrysts."

Part II, Summary of Columbia River Basalts:

Certain relationships between the mineral constituents, the glass and the crystallized minerals, between the mineralogical composition, the glass and the specific gravity were found.

The crystallization of the augite is apparently more due to the presence of mineralizers in the cooling magma than the rapidity of cooling. In the scoriaceous portions of the flows near the top and at the bottom contact, which were chilled rapidly, the mineralizers were lost quickly and only a few crystals formed. These crystals are for the most part plagioclase lath, well developed and almost as large as they are in specimens found near the center of the flow where the mineralizers were retained for a much longer time. The augite in these specimens is much more abundant, the granules larger and occasionally a sub-hedral crystal is seen. That the plagioclase crystals formed beyond a nuclear stage before the flow came to rest is unlikely because flow-structure and allignment of the crystals is not apparent to any marked degree......"

Conclusions:

"Petrographically the rocks of this formation as a whole fall in a class intermediate between a basalt and an adesite, but have similar characters as rocks which have been described as augite-andesites, andesine basalts and hawaiites. The last two terms are used synonymously by most authors but in detailed description olivene is usually present in hawaiites but is not essential. Only one specimen had the characteristics of true basalt.

Type I when considered as a whole falls in the class of andesine-basalts or hawaiites. The character of which as described by Iddings[1] and Washington & Keys[2] contains in predominance as a norm andesine with the pyroxene as augite. Accessory minerals being magnetite and rods or needles of ilmenite (?). Olivene may or may not be present. The above description is characteristic of this type but with no olivene present in recognizable form. It may be occult in the groundmass with free silica, as only a quantitative analysis would show.

Type II has the characters of a labradorite-andesine basalt described by Washington and Keys from the Hawaiian Islands[1]. The description of this rock with a chemical analysis is given below:

Labradorite-Andesine Basalt.
Labradorite phenocrysts (Ab_1An_2)
Augite - rare phenocrysts of pale brown color
Groundmass.

Slender laths of andesine about Ab_1An_1 to Ab_2An_1 with many small anhedral grains of colorless augite, and some grains of ilemenitic ore. No olivene was seen. A few small patches of

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1. Shand, S. J. Eruptive rocks, Pg. 211

what appears to be orthoclase. Glass is present in some specimens, largely replacing the interstitual augite grains, and in one or two it is dark and almost opaque.

SiO_2....48.53	H_2O-.....1.09
Al_2O_3...14.26	H_2O+.....0.07
Fe_2O_3... 2.84	TiO_2.....3.72
FeO..... 9.10	ZrO_2..... n.d.
MgO..... 5.01	P_2O_5.....trace
CaO.....11.62	MnO......0.11
Na_2O.... 2.60	BaO......-n.d.
K_2O..... 0.66	99.61

Washington adds further in reference to the analysis, "It is that of a slightly sodic, but otherwise normal basalt."

The Snake River basalts of Oregon have often been considered to be of the same character as the Columbia River Basalts though slightly younger in age. A calculated norm taken from Shand[1] is inserted below:

Qtx..... 2.2	Pyroxene...32.7
Orth.... 7.6	Mag. & Ill. 8.9
Ab......24.6	Apatite.... 2.0
An......20.6	

This is approximately the same as the average composition of the Columbia River Basalt when these rocks are considered as a whole. Were the albite and anorthite combined the resulting mixture would have the composition of andesine.

The basalts of this formation have often been compared to those of the Deccan Plateau of India but the basalts of the latter appear to be more calcic as the following description will show.

'Dense, non-porphyritic rocks with no more than 10% of glass. In the majority of cases olivene is entirely absent and there is a small excess of silica. Augite and labradorite make up about 90% of the rocks and some magnetite is always present'"[2]

Petrographic descriptions with photomicrographs are included of the rock types. Mineral percentages of the rocks are summarized in tables.

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1. Washington & Keys, M.G. Petrol. of Hawaiian Is. VI Am. Jour. Sc., vol XV, Mar. 1928
2. Shand, S. J. Eruptive rocks, Pg. 212

Blake, Will, P. Origin of Submerged Forests in the Columbia River, Oregon. Am. Assoc. Adv. Aci. Pro. 23 Pt. 2, 72-4 1875

9

(Content)

"It is generally known that the Columbia River has cut its way through the basaltic rocks of the Cascade range, leaving cliffs on each side from 2500 feet to 3000 feet high, but it is not so generally understood that the stream at that point flows at a higher level than it formerly did owing to a partial filling up of the channel."

Submerged trees given as evidence.

Bonney, T. G. Volcanoes: Their Structure and Significance. G. P. Putnams' Sons 1899

10 (Content)

Crater Lake as an example of crater lakes; P. 154. Brief general notes on Mts. Hood, Adams, St. Helens, Jefferson, and the Three Sisters. Brief description of Columbia lava sheet. Oregon volcanoes compared in a very general way to other volcanoes of the world.

Bowman, I. Forest Physiography. John Wiley and Sons. 1911 P. 198.

11 (Content)

"Deformations of the Basalt Cover.
...Although the basalt plains of the Columbia River basin were formed in a nearly horizontal position, and although these plains appear to be approximately horizontal today, there are in reality many departures from horizontality. The Snake River plains are now in the form of a broad trough or downfold reaching from Lost River and Sawtooth Mountains on the north to Goose Creek and Bear River mountains on the south.

Many minor irregularities of the structure have been noted. In southern Idaho, the lavas and intercalated lake and river sediments have been gently flexed and, near the bases of the bordering mountains, broken and faulted. These structural irregularities are of considerable economic importance, for it is upon the trough-like arrangement of the beds that the artesian condition of the deeper waters depends.....

The existing relation of drainage to relief implies antecedent conditions on the part of the streams. The lava, originally disposed in an essentially horizontal position, has been deformed from this position but the deformation has not proceeded so rapidly as to rearrange the drainage courses. Stream courses laid out upon the nearly flat lava sheets in response to the initial slopes have persisted in their courses, and where there have been great uplifts athwart the streams, we now find great canyons. The explanation is one applied to the present course of the Columbia across the Cascades except that in the Cascades it was a base-leveled and to some extent a lava covered surface and not exclusively a sheet of lava that was uplifted across the path of the river. Had the lava been in its present attitude when the Snake River first gained its course, the river would now run in an opposite direction for some distance south of the great canyon."

Bretz, J. Harlen Stratigraphic Problems in the Columbia Valley Between Snake River and Willamette River. Bull. Geol. Soc. American. 32:86- 1921

12

(Content)

"...The dominant formation of this part of the valley is a great series of basalt flows.... Direct tracing up the canyon's tributary to the Columbia shows that what has long been assumed is undoubtedly correct, this series of flows is the same as that named Columbia River Basalt by Merriam in the upper John Day valley of north central Oregon and Yakima basalt by G. O. Smith in Yakima valley of central Washington."

Butler, G. and Mitchell, J. Preliminary Survey of the Geology and Mineral Resources of Curry County, Oregon. O. B. M. and G. No. 2 1916

13 (Content)

The occurrence of the following igneous rocks are described:

Greenstone Peridotite Dacite porphyry Diorite Syenite porphyry Rhyolite Basalt	The petrology and petrography of these rocks was not attempted.

Mentions the occurrence of a Cretaceous basalt at Horsesign Butte, a dark colored, fine grained, unaltered basalt composed of plagioclase and pyroxene and occuring as a stock probably connected with the gabbroic mass below.

Buwalda, J. P. Oil and Gas Possibilities of Eastern Oregon. Min. Res. of Oregon O.B.M. and G. 1921

14 (Content)

"...The whole plateau region north, west and south of the Blue Mountains is underlain by volcanic rocks of Tertiary age in the form of lava flows and interstratified tuff and volcanic ash beds..."

"The physiographic features of the country such as the mountain ranges, valleys, plains and river canyons, are all relatively young, geologically speaking. They have been formed through crustal folding and erosion since about the end of the Miocene, that is, since the outflow of the most extensive of the lava series. It has been held in the past that the Blue Mountains stood up as islands in this lava flood, but if so they were certainly much smaller and lower than at present, for the lavas still lie over much of the high areas and slope down the sides, indicating that the uplift has occurred mainly since, rather than before, the lava floods."

Referring to the main Cascade Anticline near Cascade Locks:

"The rocks which make up those folds consist mainly of lavas. The topmost or youngest rocks in the main, fold, outcropping along the rim of the gorge, are basic lavas somewhat different from those found lower down in the face; they are termed andesites and basalts by Williams and Bretz. Beneath these sheets of lava lies a formation of river gravels, sands and ash prevailingly from one to two hundred feet thick. Under this gravel formation lie the great Columbia River basalt sheets, the main foundation exposed in the gorge. The Columbia River flowed across this area before the Cascades were uplifted, and while they were slowly being upraised across its path, it cut its great channel down through the 2500 to 3000 feet of basalts....."

"Test wells put down at The Dalles, Dufur, and Pendleton hit Columbia River basalt at no great depth."

John Day Region: "A great series of black basaltic lavas of middle or upper miocene age, two to three thousand feet thick, rest upon the John Day beds and are exposed over extensive areas in various parts of the John Day region. This is the Columbia River basalt."

Blue Mountains: "The higher parts of the Blue Mountains are made of older rocks than those which compose nearly all the remainder of the state. Older Paleozoic sedimentary and early Mesozoic strata are found here, sharply folded, faulted and intruded at numerous localities by granite and other coarse-grained igneous ro rocks and covered much of the middle and lower slopes."

La Grande, Baker, Huntington: "During the Miocene basaltic lavas flowed out over the older rocks and basins of deposition were formed, in part by warping of the surface and in part by damming of the drainage lines by lava flows."

Prineville: "The great series of basaltic lavas of Miocene age, which is so extensive between The Dalles and Pendleton, known as the Columbia River basalt, extends southward through the depression followed by the Deschutes River between the Western end of the mountainous John Day country and the Cascade range and underlies much of the south-central and southeastern Oregon. The lavas extend varying distances up the south flanks of the broad east-west ridge which forms the southern part of the Blue Mountains between Prineville and Vale. The geology of some of the region stretching westward from Prineville toward the Deschutes River, northwestward beyond Madras, southwestward and southeastward toward Burns and the Harney Valley, is intimately related to this great lava series. The region is most hills, but not mountainous: it contains some exposures of sedimentary beds but the great bulk of the rock are lavas. Besides the basalts there are areas of rhyolites and rhyolitic tuff, especially in the Madras, Hay creek and Ochoco regions....."

Harney Valley: ".....The lavas, too, have been deformed somewhat by folding since their extrusion. Still later, probably during the Pliocene, basaltic lava spread as a thin sheet over nearly the whole region. It is these thin lava flows which form the rim of the Valley at so many points near Harney and Burns. The considerable slope of these thin sheets toward the Harney Valley probably indicates that the uplift of the Blue Mountains and depression of Harney Valley has in the main occurred since the outflow of these latest lava shetts."

Bend: "From a point 20 miles east of Bend in central Deschutes country fresh lava flows extend westward to the Cascade Range. They overlie older volcanic formations. The recent flows still retain in many places the rough original surfaces of cooling."

Klamath Falls: "The rocks of the Klamath Falls region are largely, if not entirely, lavas, tuff and volcanic ash beds, with occasional clay, sand and gravel formations of fresh water origin, locally of thickness to be measured in hundreds of feet.".

Southeastern Oregon: "The lava series, made up mainly of basalts, is apparently thick throughout this whole region, for in the faces of the high ranges where they may be seen in section, it is seldom that the faults, often of several thousands of feet displacement, expose the base of the volcanic series."

Buwalda, J. P. Tertiary History of the Lower Snake River Valley, Southwestern Idaho. Bull. Geol.
15 Sco. American 32 1921

(Content)

"Mammalian remains recently collected in Southwestern Idaho indicate that the Payette formation is not Eocene(?) but middle or upper Miocene, that a younger formation of Pliocene Age is also present, and that the Idaho formation is Pleistocene instead of Pliocene. The rhyolite flows are mainly, if not entirely, late Miocene or lower Pliocene, and the eldest basalts are middle or upper Miocene and no doubt represent part of the Columbia River lava series. Pleistocene basalts also occur. The results tend to indicate that the Idaho erosion surface is Neocene, possibly Pliocene, in age instead of Eocene."

Buwalda, J.P. and Moore, B.N. Age of The Dalles Beds and Satsop Formation, History of the Columbia River Gorge. Bull. Geol. Soc. America
16 40; 1929

(Content)

"Vertebrate fossils and other evidence indicate that The Dalles beds are approximately middle Neocene in age. From its relation to the Dalles beds the "Satsop" of the Columbia River gorge is of equivalent or greater age, and not the correlative of the Quarternary Satsop of the Oregon and Washington coasts. The Satsop now named "Hood River formation" was folded with the underlying Columbia lavas during the uplift of the Cascades and the cutting of the gorge. The gorge, because of the newly established greater age of the "Satsop" and other considerations, has not been excavated entirely since some date in the Quartenary, as heretofore held by some writers. The uplift and transsection began some time in the Pliocene."

Calkins, Frank C. Contribution to the Petrography of John Day Basin. Univ. Cal. Dept. of Geol. Bull. 3 1902

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Area studied defined------geological strata established:

"Igneous Rocks"

	"Rock Name	Locality	Descriptive material
Pre Eocene	Granodiorite	Middle Fork	Petrographic Description
	Granite-porphyry	Spanish Gulch	" "
	Pyroxinites	" "	" "
		& Beach Creek	" "
	Serpentine	Beach Creek	" "
	Serpentine	Desolation Creek	" "
Clarno Eocene	Pyroxene Andesite	Hald's Canyon	" " Chemical Analysis
	Hypersthene andesite	Hald's Canyon	Petrographic Description
	Hornblende andesite	" "	" "
	Hornblende-Hypersthene-andesite	Clarno's Ferry	" "
	Andesitic tuff	" "	" "
	Andesitic tuff	Cherry Creek	" "
	Quartz basalts	" "	" "
			Chemical analysis compared to that of a basalt from the Lassen Region."

"A chemical analysis by the writer is given below, with one of a quartz basalt from the Lassen peak district described by Diller."

	Cherry Creek Quartz Basalt	Basalt from Lassen Peak, Cal. (Diller)
SiO_2	59.61	57.25
Al_2O_3	15.98	16.45
Fe_2O_3	1.12	1.67
FeO	5.42	4.72
MgO	5.04	6.74
CaO	5.54	7.65
Na_2O	3.68	3.00
K_2O	1.10	1.57
H_2O at 110	0.20	
H_2O above 110	1.14	0.40
TiO_2	.65	.60
P_2O_5	.14	.20
MnO	.21	.10
NiO	.05	
SrO	Trace	Trace
BaO	.04	.03
	99.92	100.38

"The more important points of difference are the greater silica content of the Oregon rock, the smaller percentage of lime and magnesia and the higher ratio of soda to potash. Notwithstanding these differences there is a noteable resemblance between the two analysis."

Clarno Eocene	Andesite	Cherry Creek	Petrographic Description
	Spherulitic Rhyolites	Current Creek Hill	" "
	Rhyolite	Clarno's Ferry	" "

John Day Miocene	Trachyte tuff	Petrographic description
	Audesite tuff	" "
	Rhyolite	" "
	Rhyolite	analyses description

Basalt, thickness over 2000 feet

"Miocene Basalts:

Field characters and Classification:

The great basalt series above the John Day is mainly built up of heavy lava flows, the interbedded tuffs being of relatively insignificant volume. These tuffs, as far as observed by Dr. Merriam or the writer, are also basaltic. Penetrating the John Day beds at several localities and connecting with the overlying lavas are numerous basalt dykes, whose occurrence, combined with the predominance of massive lavas over tuffs, seems to give evidence that the prevailing mode of extravasation was by quiet upwelling from fissures rather than ~~by~~ explosive.

Laboratory investigation has shown that the mineralogical constitution of these basalts is remarkably constant. They are without exception normal olivine basalts of probably the most common type. This uniformity of character is not confined to the limited region discussed in the present paper but holds good for specimens collected by the writer at various points in northern Oregon and central Washington."

Mascall	Olivine basalt	General - Petrographic Discussion
	Rhyolite tuff at base	
	Interbedded basalt Tuffs	Belshaws Ranch " & analysis
Rattlesnake, Pliocene	Rhyolite & rhyolite tuff	
Recent	Ash	Chemical analysis

"Conclusions, John Day Region:

The John Day region considered as a petrographical province or part of one, is characterized to a certain extent by the fact that its rocks are all derived from what Rosenbusch calls the gabbro-peridotite and granito-diorite magmas. Rocks allied to Nepheline syenite are quite unrepresented. The preponderance of soda molecules over potash in all the rocks analyzed is also a significant fact; and the recurrence of anorthoclase - bearing rhyolites of similar type in Eocene, Miocene, and Pliocene times is significant of a certain persistency or petrographical character of the region.

Any comprehensive study of a great series of volcanic rocks should include some attempt to discover whether the succession of chemical types obeyed any definite law... The general order seems to afford a fairly strong confirmation of Idding's theory that the normal succession is from intermediate to more basic and more acid types.

In the Eocene we seem to have a complete cycle in accordance with this theory. The period extending from the base of the John Day to the top of the Rattlesnake formation may be considered as a second cycle, though the presence of rhyolite apparently balanced by no corresponding basic eruption in the middle of the John Day andesite tuffs, indicates an apparent failure of the rule. Since, however, such a basic member was not especially looked for, a failure to observe it does not prove its absence."

Micro drawings of the following rocks also appear:

Hornblende andesite	Clarno's Ferry
Pyroxene andesite	
Green tuff	Turtle Cave
John Day Rhyolite	Antelope
Semi ophitic basalt	
Glassy basalt	The Dalles

Callaghan, Eugene: Some Features of the Volcanic Sequence in the Cascade Range in Oregon. Amer. Geophysical Union Transactions, Fourteenth Annual Meeting, 1933.

18

(Content)

"The following is a condensed version of part of a report on geology and ore-deposits of Cascade Range in Oregon in preparation; it is published by permission of the Director, United States Geological Survey... For purposes of geologic description it has been found convenient to divide the Cascade Range south of Mount Hood in two parts, the western Cascades and the High Cascades on the basis of a pronounced unconformity in the stratigraphic sequence of the lavas. This is turn accounts for the rolling upland character with partial or total preservation of volcanic surfaces or probably very late Tertiary and Quaternary rocks in the high Cascades as compared with the deeply dissected surface on an older volcaic surface in the Western Cascades.

The constituents of the above mentioned divisions are discussed and their locations are shown on a small generalized map. The lavas that form the base of the succession in most parts of the Western Cascades are characterized by their prevailing black appearance, and by their occurrence as flows that have great lateral extent as compared to their thickness, and therefore present a distinctly bedded appearance. In many respects they closely resemble the Columbia River basalt and are generally called basalts, though chemical and microscopic study indicates that probably few of the flows are true basalts. The analysis of one of these black lavas in column 3 Table I shows that the SiO_2 is high and the content of CaO and iron oxides approaches those in ordinary andesite. (It has been found necessary to distinguish between andesites and basalts on the basis of proportion of ferromagnesian to feldspathic constituents rather than the kind of plagioclase because of the relatively high CaO content of the plagioclase and the large proportion of SiO_2). Analysis of the two black lavas of the Columbia Plateau are included in the same table for comparison. Under the microscope this black lava shows phenocrysts of labradorite, augite, and magnetite together with very small grains of the same minerals in a brown glass base. It is the glass, and not a predominance of ferromagnesian constituents, that makes the rock black. Olivine crystals are not abundant though pseudomorphs occur in a number of flows examined.

References for Numbered Columns (Table I) as to Rock,

Place and Analyst.

1. Basalt, The Dalles, Ore. H. S. Washington

2. Yakima basalt, Calaum Ridge, Washington. G. Steiger

3. Black labradorite andesite, McNeil Creek, Jackson County, Oregon. J. C. Fairchild

4. Labradorite andesite, near Grizzly Saddle, Bohemia dist. Lane County, Oregon. G. Steiger

5. Labradorite andesite, top of Gold Hill, Blue River dist., Oregon. G. Steiger.

6. Labradorite andesite, Bohemia Mt.

7. Augite andesite, South Grouse Mt.

8. Rhyolite, Vesuvius mine

Bohemia District, Ore.
G. Steiger

9. Average plateau basalt. (Daly, R. A., 1925)

10. Mean of 20 analyses of hypersthene and augite andesite. (Osann - Rosenbusch, 1923)

Table I. Analysis and Norms of Typical Rocks of Western Cascades and Related Rocks

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
SiO_2...	49.08	54.50	57.47	53.27	54.25	55.18	62.72	69.58	49.3	59.3
Al_2O_3..	13.71	14.43	14.95	17.08	16.46	15.57	15.04	13.68	14.1	16.6
Fe_2O_3..	1.25	2.17	2.05	2.93	3.08	3.30	1.73	1.39	3.4	3.1
FeO....	13.02	8.80	7.18	6.06	5.92	6.06	4.44	1.88	9.9	3.5
MgO....	4.58	4.24	2.74	5.12	4.46	4.15	2.19	0.63	6.4	3.4
CaO....	8.44	8.01	6.63	9.63	8.79	7.60	3.83	2.68	9.7	6.3
Na_2O...	3.17	3.05	3.45	2.28	3.46	3.08	4.18	3.66	2.9	3.6
K_2O....	1.31	1.29	2.15	0.72	0.80	1.40	2.26	3.22	1.0	1.9
H_2O-...	0.09	1.09	0.55	1.52	1.32	2.03	1.91	1.46		
H_2O-...	0.20	0.29	0.45	0.15	0.26	0.40	0.34	0.45		
CO_2....				0.08		0.07	0.38	1.38		
TiO_2...	3.56	1.69	1.60	1.04	1.28	1.46	0.95	0.44	2.6	0.7
P_2O_5...	0.73	0.21	0.32	0.20	0.23	0.14	0.21	0.09	0.5	0.2
MnO....	0.25	0.10	0.12	0.15	0.13	0.14	0.10	0.07	0.2	0.1
	100.20	100.13	99.66	100.20	100.44	100.48	100.28	100.61		

-Norms-

	1.	2.	3.	4.	5.	6.	7.	8.
Q......		7.02	10.32	8.82	6.12	9.42	17.28	32.82
or.....	7.78	7.78	12.79	3.89	5.00	8.34	13.34	18.90
ab.....	27.25	25.68	28.82	19.39	29.34	26.20	35.63	30.92
an.....	18.90	21.68	19.18	34.47	26.97	24.46	15.29	3.61
c......								2.86
wo.....	7.89	7.19	4.99	5.34	6.61	5.45		
en.....	8.80	10.60	6.90	12.80	11.20	10.30	5.50	1.60
fs.....	13.33	11.75	8.98	7.26	6.47	6.20	5.28	1.72
fo.....	1.89							
fa.....	3.06							
mt.....	1.86	3.25	3.02	4.18	4.14	4.64	2.55	2.09
il.....	6.84	3.19	3.04	1.98	2.43	2.89	1.82	9.76
ap.....	1.68	0.34	0.67	0.34	0.34	0.34	0.34	0.34
cc.....								

Table 2. Analyses and Norms of Intrusine Rocks in Western Cascades and a Related Rock in Washington.

SiO_2....	52.67	61.99	65.16	65.71	64.04
Al_2O_3...	17.36	15.69	15.24	14.29	15.58
Fe_2O_3...	3.37	2.96	2.08	2.44	1.26
FeO.....	5.14	2.85	3.04	2.85	3.22
MgO.....	5.06	2.76	2.22	2.15	3.23
CaO.....	8.80	4.62	4.69	4.13	4.51
Na_2O....	3.06	3.52	3.62	3.55	4.01
K_2O.....	0.73	1.60	2.08	2.42	2.22
H_2O.....	2.15	1.83	0.77	0.82	1.17
H_2O.....	0.18	0.13	0.13	0.11	0.19
CO_2.....	0.09	0.75	0.17		
TiO_2....	0.13	0.73	0.74	0.81	0.69
P_2O_5....	0.29	0.31	0.29	0.20	0.16
MnO.....	0.17	0.06	0.09	0.18	Trace
	100.20	99.80	100.32	99.66	100.39

-Norms-

Q.......	6.72	23.76	23.16	23.94	17.34
or......	3.89	9.45	12.23	14.46	12.79
ab......	25.68	29.34	30.39	29.87	43.06
an......	31.97	16.40	19.18	15.85	18.07
c.......		2.24			
wo......	3.94		0.58	1.51	1.39
en......	12.70	6.90	5.60	5.40	8.00
fs......	5.15	1.58	2.77	2.24	3.56
mt......	4.87	4.41	3.02	3.48	1.86
il......	2.13	1.37	1.37	1.52	1.37
ap......	0.67	0.67	0.67	0.34	0.34
cc......	0.20	1.70	0.40		

References for Numbered Columns (Table 2).

1. Augite diorite, Small plug, Bohemia District, Oregon T. Kamada.

2. Augite dacite porphyry, Small plug, Bohemia District, Oregon. R. B. Ellestad

3. Augite, hypersthene granodiorite porphyry core of dike, Bohemia District, Oregon. T. Kamada.

4. Hornblende augite granodiorite, small stock, Bohemia District, Oregon. R. B. Ellestad.

5. Hornblende, biotite granodiorite, Snoqualmie Batholith, Kittitas Co., Washington. H.N. Stokes.

Table 3. Analyses and Norms of Typical Rocks of the High Cascades and Related Rocks.

	1.	2.	3.
SiO_2	49.85	47.10	47.60
Al_2O_3	12.20	18.52	18.27
Fe_2O_3	1.69	Trace	1.91
FeO	10.50	7.91	8.93
MgO	6.25	10.89	6.54
CaO	9.43	11.98	8.70
Na_2O	3.08	2.33	3.11
K_2O	0.97	Trace	1.03
H_2O	0.24	0.10	0.80
H_2O-		0.18	0.33
TiO_2	2.50	0.90	2.20
P_2O_5	0.40	0.09	0.29
MnO	0.16	Trace	Trace
	100.27	100.00	.00.08

4. 5. 6. 7. 8. 9.

Note--
Columns 4 to 9, Crater Lake rocks, inclusive of this table have been omitted here as they are contained under Diller, page .

-Norms-

	1.	2.	3.
Q			
or	6.12		6.12
ab	26.20	17.82	26.20
an	24.46	40.03	32.80
ne		0.85	
wo	8.24	7.77	3.60
en	10.20	4.90	4.80
fs	9.24	2.38	3.30
fo	3.78	15.54	8.32
fa	3.67	8.36	6.12
mt	2.55		2.78
il	4.71	1.67	4.26
ap	1.01	0.34	0.67

References for Numbered Columns (Table 3).

1. Olivine basalt, Cupola Rock, Lost Creek, Lane County, Oregon. J. G. Fairchild.

2. Ophitic basalt, Laird's Ranch, Modoc area, California. W. H. Herdsman.

3. Basalt, Steens Mountain, Harney County, Oregon. W. H. Herdsman.

"In summation, it may be pointed out that volcanoes have been active in the Cascade Range in Oregon from Eocene to Recent time. There is at least one distinct break in the area south of Mount Hood during which the volcanic rocks of the Western Cascades were formed, cut by intrusive stocks, subjected to the effects of mineralizing solutions, and deeply dissected before the lavas of the high Cascades are separated into two groups - one that is characterized by black lavas, chiefly calcic andesites, with associated rhyolites, andesites, tuffs, and agglomerates, and another, mainly stratigraphically higher, that consists of grey calcic andesites, more sodic andesites, rhyolites, and associated pyroclastics. These rocks contain many alteration products, which resulted largely from contactmetamorphism and activity of subsequent vein-forming solutions. The rocks that form the high Cascades are characterized by a large mass of grey Olivine basalt, large cones composed mainly of hypersthene andesite, rhyolite and pyroclastics, and andesite, calcic andesite, basalt and possibly other types. Chemically, the great bulk of the rocks, with the exception of the Olivine basalt, is saturated with respect to silica, CaO is abundant, equalling the oxides of iron in calcic andesites, and K_2O is low, not exceeding Na_2O even in the most siliceous rocks yet analyzed. Mineralogically, the phenocrysts of feldspar range from bytownite to oligoclase; augite is the most abundant ferromagnesian mineral, hypersthene is abundant in the rocks of the High Cascades, but uncommon in the Western Cascades where it may be represented by chloritic pseudomorphs. Biotite occurrs in a rhyolite at the base of the series west of Crater Lake and in a few dikes. Hornblende is limited to the siliceous rocks and is not abundant in the western Cascades. Quartz phenocrysts are not common even in many of the rhyolite flows. Orthoclase is limited to interstitial material or replacement of plagioclase. Olivine is not abundant in the western Cascades though it is represented by pseudomorphs in many flows. Usually the flows of the western Cascades are much more altered than those of the high Cascades. In general, it appears that there have been no pronounced chemical or mineralogical trends during the accumulation of this tremendous pile of volcanic rocks, which probably accumulated during all the major epoch of the Cenozoic. What may be regarded as an exception is the extravasation of the large mass of olivine basalt following a period of quiescence of unknown duration."

Campbell, I. A Geologic Reconnaissance of the McKenzie River Section of the Oregon Cascades with Petrographic Descriptions of some of the More Important Rock Types. University
19 of Oregon Thesis, 1923.

(Summary)

"The rocks, as already predicted, are mostly of a fine grained basic type, andesites and basalts. Augite basalts are the common type - with labradorite as the chief feldspar, Olivine basalts occur; but they are rare. Biotite, likewise, is not often found as a constituent mineral. Hornblende is conspicuous by its absence, probably not even occurring as an accessory in the more acidic types of rocks.

Hypersthene has been noted in one instance of the accessories, magnetite is by far the commonest. It is almost universally present, and sometimes in quite considerable amounts. Apatite, too, is frequently found, often as inclusions in the feldspar phenocrysts. Zircon and titanite were noted in the Nimrod granite.

Weathering proceeds rapidly, and absolutely fresh rocks are exceedingly difficult to find. Saussuritization of the feldspars and chloritization of the ferromagnesian minerals are the common phases exhibited.

Both acidic and basic types of rock are found in the area, the latter greatly predominating. Only fine and medium grained rocks occur, however; no coarse grained types, such, for instance, as the granodiorite - erratics which are found in the Eugene Quadrangle, are known in place from the area.

These conclusions are in general agreement with Iddings definition of the Cascade type. He found that most of the rocks were pyroxene andesites. The writer's experience locally has shown somewhat of a preponderance of more basic types, at least in the lower McKenzie valley; but pyroxene is still next to feldspar, the chief constituent."

The following rocks are petrographically described and appear with photomicrographs.

1. Basalt
2. Rhyolite
3. Basalt
4. Basalt
5. Quartz Monzonite (Probably a Quartz diorite as Orthoclase is not present.)
6. Granite
7. Andesite
8. Basalt
9. Diabase
10. Basalt

20 Chaney, Robert W. Ecological Significance of the Eagle Creek Flora of the Columbia River Gorge. Journal of Geology. 1918

P. 277 Discusses:

Nature of the Eagle Creek Formation, conditions of deposition, relations to basalt, climate and time of duration.

21 Clarke, F. W. Analysis of Rocks and Minerals from the Laboratory of the United States Geological Survey. U.S.G.S.Bull. 591 197-203. 1915

1. Basalt Mt. Thielsen

Partly described by Diller. A hypersthene basalt

containing: hypersthene
olivine
feldspar
magnetite"

	A	B	C	D	E	F
SiO_2....	55.68	53.31	55.48	51.95	55.85	55.04
Al_2O_3...	18.93	5.99	26.91	28.84	22.95	
Fe_2O_3...			2.32	2.42	4.59	28.99
FeO.....	8.73	13.43				
MgO.....	4.86	21.69	2.27	1.34	3.08	5.85
CaO.....	7.99	3.69	8.11	11.42	8.41	7.86
Na_2O....	2.12		3.14	3.22	2.16	
K_2O.....	.48		.72	.59	2.67	
H_2O.....	.60		.66	.40	.52	1.11
TiO_2....			.39	Trace		
P_2O_5....					Trace	

Reference for columns:

A. Hypersthene Basalt
B. Pyroxene
C. Feldspars
D. Feldspars
E. Groundmass
F. Fulgurite

"Riddles Quadrangle:"

	A.	B.	C.	D.	E.	F.
SiO_2....	41.43	42.81	70.65	58.25	57.06	50.01
Al_2O_3...	.04		15.57	20.52	8.50	15.25
Fe_2O_3...	2.52	2.61	.57	.68	1.11	2.72
FeO.....	6.25	7.20	1.26	3.88	5.40	5.35
MgO.....	43.74	45.12	.48	2.03	11.19	9.35
CaO.....	.55	None	3.28	7.88	12.04	10.44
Na_2O....			4.91	4.25	1.39	1.50
K_2O.....			1.77	.50	.95	.60
H_2O.....	94.41	.57	.14	.24	.18	2.61
H_2O.....	94.41	.57	.86	1.10	1.25	1.35
TiO_2....			.21	.57	.52	.68
ZrO_2....			.01	.01	None	None
CO_2.....			Trace	None	None	None
P_2O_5....			.07	.16	.05	.03
S.......			.07	None	None	None
Cr_2O_3...	.76	.79				
NiO.....	.10	.26				
MnO.....	None	None	.06	.10	.13	.12
BaO.....			.06	None	Trace	None
SrO.....			Trace	None	None	None
	99.80	99.36	99.97	100.17	99.77	100.01

Reference for Riddles Quadrangle Columns:

A. Peridotite, the matrix of the silicate nickel ores. Described by Diller and Clarke in Bull. 60, p. 61. The rock which may be classed as a saxonite, consists essentially of: olivine, enstatite, chromite, magnetite.

> "Olivine predominates, and enstatite forms less than one third of the mass. Quartz serpentine and genthite are present as alteration products."

B. Olivine separated from A.

C. Dacite porphyry. Sec. 5 T 30 S. R. 6 W. Lassenose

D. Granodiorite Sec. 26 T 30 S. R. 3 W. Hessose

E. Intermediate rock between greenstone and granodiorite Evans creek near mouth of Sykes Creek, Vaalose.

F. Augite andesite, south bank Umpqua River 3/8 mile west of Day's Creek, Auvergnose.

	G.	H.	I.	J.
SiO_2	50.90	52.58	45.86	46.36
Al_2O_3	16.71	15.58	15.52	16.88
Fe_2O_3	.40	2.17	1.84	2.23
FeO	8.50	6.68	3.22	6.29
MgO	5.14	5.35	11.71	8.15
CaO	9.74	10.37	15.57	15.66
Na_2O	3.50	1.79	.86	1.17
K_2O	.60	.82	.12	.10
H_2O	.03	.22	1.38	.21
H_2O	2.12	3.13	3.70	1.48
TiO_2	1.80	.89	.22	1.29
CO_2	.51	.22	None	None
P_2O_5	.17	.09	None	None
S	None	None	.01	.01
MnO	.13	.15	.07	.10
BaO	.02	.03	None	None
SrO	Trace	Trace	None	None
	100.17	100.37	100.13	99.93

References for Columns:

G. Drabasic greenstone sec 2 T 30 S.R. 6 W. Beerbachose

H. Basaltic greenstone sec 23 T 31 S.R. 6 W. Koghose

I. Gabbroic greenstone sec 2 T 34 S. R. 6 W.

J. Dioritic greenstone sec 29 T.S.R. 6 W. Owenose

Crater Lake

Rocks collected by Diller:

A. Vitrophyric rhyolite, south edges of Lalao Rock flow, Lassenose.

Contains:

Plagioclase

Hypersthene

Hornblende

And apatite (in glassy groundmass crowded with augite microlites.)

B. Streaked rhyolite, near "Wine Glass" Grotto Cove, Lassenose.

Contains:

Plagioclase

Hypersthene

Hornblende

Magnetite, with black glass. A few small inclusions of basalt and hypersthene andesite.

C. Rhyolite, small dike immediately below Llao rock, Lassenose.

Plagioclase

Hornblende

Hypersthene

Magnetite, in glassy groundmass crowded with microlites of feldspar and augite.

D. Rhyolite, waters edge, head of Cleetwood Cove, Lassenose.

Contains:

Plagioclase

Hypersthene

Brown hornblende

Magnetite, in a feldspathic groundmass of trachytic type.

E. Hypersthene-augite-andesite, large dike transsecting the northwestern portion of the crater rim, Tonalose.

Contains:

Plagioclase

Hypersthene

Augite

Magnetite, in a groundmass having a moderate amount of glass.

F. Hypersthene, Augite andesite, west edge of Wizard Island, Tonalose.

Contains: Same minerals as E.

	A.	B.	C.	D.	E.	F.
SiO_2......	70.77	68.17	71.78	70.10	60.09	59.39
Al_2O_3......	14.83	15.60	14.53	15.18	17.85	18.45
Fe_2O_3.....	1.35	2.31	1.28	1.78	2.03	1.79
FeO.......	1.25	.94	1.02	1.09	3.45	3.90
MgO.......	.64	1.02	.48	.74	3.50	3.13
CaO.......	2.12	2.76	1.59	2.27	6.28	6.29
Na_2O......	5.07	5.15	5.08	5.15	4.17	4.29
K_2O.......	2.68	2.46	2.84	2.58	1.31	1.29
H_2O-.......	.07	.09	.06	.10	.12	.10
H_2O-........	.33	.45	.22	.19	.26	.42
TiO_2.....	.38	.54	.411	.48	.54	.41
P_2O_5.....	.13	.13	.10	.13	.23	.22
ZrO_2.....	.05	None	.04	.04	None	None
NiO.......	None	None	None	None	.05	None
SrO.......	.02	.03	.03	.03	.05	.04
BaO.......	.08	.06	.08	.08	.05	.05
Li_2O......	Trace	Trace	Trace	Trace	Trace	Trace
Cl........	.11	Trace	Trace	.03	Trace	Trace
	99.88	99.71	99.63	99.97	99.98	99.77

Traces of manganese in all.

Norms for Column C. from Clarks Data of Geochemistry.
U.S.G.S. Bull. 770

Q......27.4
or.....16.7
ab.....43.0
an..... 8.1
hy..... 1.2
mt..... 1.4
il..... .8

G. Hypersthene-augite andesite, crater rim just south of "The Watchman", Tonalose.
Contains: Same minerals as F.

H. Hypersthene-augite andesite, Palisades, under Round Top northeast portion of the rim, Tonalose.

Contains:

Plagioclase

Hypersthene

Augite

Magnetite

I. Hypersthene augite andesite, lake level under Llao rock Tonalose.

Contains:

Same minerals as H

J. Basalt, base of red cone, Andose

Contains:

Plagioclase

Augite

Olivine

Magnetite, with some glass base.

	G.	H.	I.	J.
SiO_2.....	60.98	62.09	58.41	52.99
Al_2O_3....	17.82	17.03	17.85	16.71
Fe_2O_3....	1.83	2.38	2.67	3.80
FeO......	3.33	3.69	3.29	3.55
MgO......	2.76	3.08	3.61	6.95
CaO......	5.73	5.65	6.81	8.49
Na_2O.....	4.26	4.10	3.77	3.56
K_2O......	1.43	1.67	1.23	1.29
H_2O-.....	.13	.04	.34	.18
H_2O-.....	.45	.13	.86	.59
TiO_2.....	.71	.65	.69	1.18
$P2O_5$.....	.17	.19	.24	.42
ZrO_2.....	None	None	None	.02
NiO......	Trace	Trace	Trace	Trace
SrO......	.05	.07	.05	.12
BaO......	.06	.07	.05	.07
Li_2O.....	None	None	Trace	None
Cl.......	Trace	Trace?	Trace	Trace
	99.71	99.84	99.87	99.92

K. Hypersthene basalt, Anna Creek, andose-beerbachose.

Contains:

Plagioclase

Augite

Hypersthene

Olivine

Magnetite

L. Hypersthene basalt, andesitic type, north Desert Cove Tonalose.

Contains:

Plagioclase

Hypersthene

Augite

Olivine

M. Dark secretion from among Dacitic ejectamenta summit of Llao Rock, Tonalose-Andose.

Contains:

Plagioclase

Hornblende

Hypersthene

Augite

Olivine and apatite, in a dark brown glassy groundmass.

N. Light colored secretion from among Dacitic ejectamenta southern rim of crater between sand and Anna creeks, Lassenose.

Contains:

Plagioclase

Hypersthene

Augite

Hornblende

Biotite

Quartz

O. Basalt, 1 mile east of summit of Cascade range, on the road from Fort Klamath to Crater Lake--Beerbachose.

Described as a typical basalt carrying considerable amount of hypersthene.

	K.	L.	M.	N.	O.
SiO_2	56.95	58.65	56.85	67.41	57.47
Al_2O_3	18.84	18.35	18.31	15.76	18.86
Fe_2O_3	2.06	1.59	2.88	1.88	2.21
FeO	4.28	4.21	3.15	1.76	4.08
MgO	4.37	3.49	3.92	1.35	3.27
CaO	7.45	6.95	7.20	3.36	7.42
Na_2O	3.89	3.70	3.89	4.54	3.85
K_2O	.82	1.32	1.23	2.36	.73
H_2O-	.19	.20	.16	.09	.22
H_2O-	.31	.70	.95	.54	.22
TiO_2	.79	.81	1.08	.56	.75
P_2O_5	.19	.17	.22	.12	.24
S	Trace	None	None	.02	
MnO	Trace	Trace	Trace	Trace	.10
BaO	.04	.06	.04	.06	.03
SrO	Trace	Trace	Trace	Trace	.11
	100.18	100.20	99.88	99.81	100.34

3. Port Orford Quadrangle

Rocks collected by J. S. Diller and partly described by him in folio 89.

A. Serpentine, from 12 miles north of Boulder Creek.

B. Serpentine from Iron Mountain Crest.

Contains with serpentine:

Olivine

Pyroxene

Hornblende sometimes

Magnetite with picotite or chromite.

C. Metagabbro, southeast slope of Panther Mountain, Hessose.

Contains:

Plagioclase

Pale green fibrous hornblende.

Fine scales of mica and small groups of epidote are common.

D. Normal Metagabbro, summit of Bald Mountain, Auvergnose.

Contains:

Plagioclase

Hornblende

Grains of magnetite or ilmanite

Traces apparently of pyroxene.

	A.	B.	C.	D.
SiO_2	39.42	38.55	44.19	50.14
Al_2O_3	1.39	1.32	20.66	15.26
Fe_2O_3	3.42	5.55	.52	1.19
FeO	4.29	2.17	3.26	8.75
MgO	39.68	39.06	11.90	7.21
CaO	1.10	.85	10.76	9.34
Na_2O	None	.10	1.35	2.76
K_2O	None	.05	1.03	.95
H_2O-	.36	1.14	.74	.23
H_2O+	9.53	10.14	5.19	2.22
TiO_2	None	Trace	.12	1.42
ZrO_2	None	None	None	None
CO_2		.51	.06	None
P_2O_5	None	Trace	Trace	.24
S		.03	Trace	.04
Cr_2O_3	.58	.48	.15	Trace
NiO		.13	.03	
MnO	Trace	.05	.11	Trace
BaO	None	None	.04	.03
SrO		None	.05	None
Li_2O		Trace	?	None
	99.77	100.13	100.16	99.78

E. Gabbro, Brush Creek 1½ miles southwest of Bald Mt., Yellowstonose.

Rich in quartz and feldspar, with subordinate biotite and hornblende. Contains some chlorite.

F. Gabbro, west of Brush Creek near summit of Mussel creek divide, Kilanase.

Chiefly feldspar and pyroxene, the latter partly changed to hornblende. A little quartz is present.

G. Gabbro, left bank of Rogue river, 2 miles below the mouth of the Illinois River, Monzonose.

Consists mainly of plagioclase and hornblende.

H. Basalt, Cedar Creek, 1½ miles northeast of Ophir, Auvergnose.

Consists mainly of feldspar and hornblende. Grains of pyroxene are present, and a black dust which appears to be magnetite.

I. Basalt, near fork of west Bend trail, 2¼ miles south of Johnston Creek. Berbachose.

Contains:

Plagioclase

Pyroxene

Hornblende } Secondary
Chlorite }

	E.	F.	G.	H.	I
SiO_2.....	60.88	56.45	57.43	50.56	52.13
Al_2O_3....	17.71	13.81	17.69	14.49	15.21
Fe_2O_3....	2.92	1.73	1.59	1.78	1.83
FeO......	2.17	3.95	3.48	10.20	8.95
MgO......	2.21	8.67	2.73	5.90	6.01
CaO......	4.32	6.69	5.72	10.13	3.75
Na_2O.....	4.17	5.03	7.19	2.91	4.83
K_2O......	2.68	.46	.58	.38	.48
H_2O+......	.54	.67	.48	.20	.90
H_2O-	1.47	2.02	1.81	1.50	3.74
TiO_2.....	.41	.31	.66	1.67	1.38
ZrO_2.....			None	None	None
P_2O_5.....	.16	.02	.17	Trace	.14
CO_2......	None	None	.10	?	.09
Cr_2O_3....	None	Trace			None
NiO......				Trace	.03
S........	Trace	Trace	.02		Trace
FeS_2.....				.28	
MnO......	Trace	Trace	.17	.25	.19
BaO......	.06	Trace	None	Trace	Trace
SrO......	Trace	.02	.02	None	None
	99.70	99.83	99184	100.25	99.65

J. Basalt, Sawtooth Rock.

Largely feldspar and pyroxene with some quartz.

K. Dacite porphyry, 6 miles west of highland of Rogue River. Kallerudose.

Contains plagioclase and quartz with some orthoclase, and scattered patches of chlorite and hornblende.

L. Dacite porphyry, head of Boulder creek, Yellowstonose.

Contains: Abundant quartz altered feldspar, grains of epidote, hornblende and chlorite.

M. Dacite porphyry, south slope of Bald Mountain. Alsbachose-lassenose.

	J.	K.	L.	M.
SiO_2.....	53.06	71.45	70.33	75.32
Al_2O_3....	12.83	14.53	15.74	13.17
Fe_2O_3....	1.20	.49	1.43	.27
FeO......	5.10	.94	.83	.98
MgO......	7.50	.30	.53	.42
CaO......	13.71	2.01	3.38	1.48
Na_2O.....	3.56	7.15	4.33	4.77
K_2O......	.05	2.55	1.87	2.14
H_2O-.....	.16	.15	.20	.18
H_2O+.....	2.16	.38	1.16	.73
TiO_2.....	.42	.16	.27	.16
CO_2......	.25	.08	Trace	.03
ZrO_2.....	Trace?	Trace	None	None
P_2O_5.....	Trace	.09	.06	.04
S........	Trace	Trace	Trace	
FeS_2.....				.09
MnO......	.16	Trace	Trace	Trace
BaO......	None	.03	.09	.23
SrO......	None	None	Trace	.02
Cr_2O_3....	.06			
NiO......	Trace			
	100.22	100.31	100.22	100.03

A. Granodiorite, normal from near lake at base of Bald Mt. northwest of Sumpter Yellowstonose. Described by Lindgren:

Contains:

Quartz

Hornblende

Andesine

Orthoclase

Biotite

Magnetite

Slight alterations to epidote and chlorite are sometimes noticeable.

B. Tuff, partly igneous, from Wilbur, Doublas Co.

The igneous matter contains a few grains of feldspar and augite with particles of a rock-like diabase. Organic remains partly calcareous - partly silicious. Described by J. S. Diller.

C. Basaltic tuff, Columbia River, 25 miles east of Portland.

Described by Diller.

	A.	B.	C.
SiO_2	71.23	55.15	40.89
Al_2O_3	14.61	9.75	10.41
Fe_2O_3	.93	7.76	15.00
FeO	1.66		.07
MgO	1.01	2.22	3.76
CaO	3.29	10.48	5.18
Na_2O	4.00	1.00	.47
K_2O	1.92	.50	.53
H_2O+	.17	2.70	9.14
H_2O-	.55	6.59	10.32
TiO_2	.34		3.37
CO_2		3.64	None
ZrO_2	.02		
P_2O_5	.14		.52
S	Trace		.03
MnO	.08		.90
V_2O_3			.01
BaO	.08		
SrO	.02		
Li_2O	Trace		
	100.05	99.79	100.60

Average Composition of Rocks - Clarke

Element or Compound	Number of Determinations	Average Percentage	Elements
Silica	1714	60.86	O 47.09
Alumina	1193	15.17	Si 28.22
Ferric Oxide	1242	2.70	Al 7.93
Ferrous Oxide	1238	3.52	Fe 4.57
Magnesia	1328	3.88	Mg 2.31
Lime	1564	4.93	Ca 3.48
Soda	1632	3.44	Na 3.44
Potash	1624	3.05	K 2.50
Water -100°	294	1.80	H .16
Water +100°	959	1.45	Ti .48
Titanic Oxide	1140	.80	Zr .017
Zirconia	372	.023	C .131
Phosphoric Oxide	1136	.29	P .121
Baryta	793	.104	S .011
Strontia	649	.04	C. .060
Manganese Oxide	1155	.10	F .026
Carbon Dioxide	730	.49	Ba .090
Lithia	581	.011	Sr .034
Nickel oxide	299	.026	Mn .077
Chromic oxide	293	.05	Ni .023
Vanadium trioxide	102	.026	Cr .034
Chlorine	265	.064	V .017
Fluorine	112	.10	Li .009

Clarke, F.W. Some Nickel Ores from Oregon. U.S.G.S. Bull.
22 60 21-6 1890

Description of the deposit at Riddle.

Analysis of ore:

Loss at 110°C	8.87
Loss on ignition	6.99
Al_2O_3- Fe_2O_3	1.18
SiO_2	44.73
MgO	10.56
NiO	27.57
	99.90

Analysis of Country Rock: And Olivine from Rock:

	Rock	Olivine
Ignition	4.41	.57
SiO^2	41.43	42.81
Al_2O_3	.04	
Cr_2O_3	.76	.97
Fe_2O_3	2.52	2.61
FeO	6.25	7.20
NiO	.10	.26
MnO	None	None
CaO	.55	None
MgO	43.74	45.12
	99.80	99.36

"It will be seen from these data that the rock contains nickel, and that the olivine separated from it contains an even larger proportion. This fact suggests a probable source of derivation for the nickel in the altered beds of ore and this view is maintained by the microscopic investigation...... The evidence points to saxonite as a source of the nickel."

Collier, A. J. The Geology and Mineral Resources of the John Day Region. O.B.M.&G. 1 No. 3 1914

23

(Content)

Mentions occurrence of Columbia lava sheet and incidentally a few other igneous rocks. A geologic map by Merriam and compiled by Collier of the John Day Valley is included.

Courtis, William M. Amarillium. A.I.M.E. Transaction 33:347 1903

24 (Content)

Account of discovery of an apparently new metal (amarillium) but suggests that it may be identical with Josephenite.

Dana, J. D. Geology of S. S. Explorations. Exploration Under Charles Wilkes. 10:611-78 1849

25 (Content)

States that fissures were the dominant source of the Columbia River basalts. He states that the eruption of these basalts and lavas had taken place from fissures throughout the country,--fissures which were more numerous near the volcanic peaks, but also intersected the whole region to the coast. They cut through the Tertiary rocks, and were also interstratified with them.

Diller, J. S. Observations in the Cascade Range, Oregon Science 3:52 3 1884

26 (Content)

"Andesites and basalts are found on the west side; and at Oregon City the basalts have a thickness of 300 feet. The massive rocks stretch far southward toward Salem; and on them rest the extensive alluvial deposits which form the fertile plains in the valley of the Willamette".......

"The Cascade range, constituted almost wholly of basic lavas, is a low, broad arch, not less than seventy-five miles in diameter, rising from 3,300 feet at Summit Prairie near Mt. Hood to 5,600 feet at Crater Lake. About the head of the Deschutes River the general plain, which more or less gradually merges into the slope of the mountains, has a height of 4700 feet. Throughout Oregon this plain lies about a thousand feet below the general crest of the range; and both are formed of lava sheets arising from fissure eruptions. There are numerous topographical elements on the broad arch produced by local extrasions or subsequent erosion, lava having been poured from many craters that rise from eight hundred to eight thousand feet above the arch forming an irregular series of ridges having here and there a radial arrangement. Some are on a line as though from a common fissure; but for the most part they have irregular distribution. The great peaks of the range are all remnants of old craters. The larger ones form the most prominent peaks of the system, and although post Miocene in age, are older than many of the smaller ones, which are mainly cinder cones, which retain their crater form more or less perfectly. As a rule also the latter are basaltic while the chief mass of the larger ones is andesitic."

Diller, J. S. A Fulgerite from Mt. Thielson, Oregon
Science 3 735 1884.

27 (Content)

"The material fused by lightning was cooled so quickly that it all remained amorphous and formed a dark porous glass. In order to test the conclusions reached in the microscopical analysis an attempt was made to crystallize the fulgerite. A completely amorphous fragment was heated without fusion in a Bunsen lamp flame for six hours, and then found in polarized light, to be made up of strongly doubly refracting fibers, with a marked tendency to spherulitic arrangement. A finely pulverized portion was fused and as highly heated as possible in a blast lamp for 4 3/4 hours and then allowed to cool gradually. Under the microscope it was found that much of the feldspar, some pyroxene and many undeterminable microlites crystallized out of the glass during the heating. The various stages in the development of feldspar crystals from the more or less regular groups of microlites through lath shaped bundles of fibers to a completely clear, transparent, crystal, are easily traced. The microscopical as well as the chemical evidence and that derived from the recrystallization of the fulgerite, all indicate that the fusion was confined chiefly to the siliceous groundmass of the rock with which the fulgerite is associated. The rhombic pyroxene was also fused to some extent, while the plagioclase feldspar and olivine were not affected; the examination also indicates that the composition of the glass derived from the fusion of parts of a heterogenous rock is a function of the fusibility and electric resistance of its various constituents."

(Chem. Analysis, see Clark, F.W.)

Diller, J. S. Rocks from Oregon. Science 4:71 1884

28 (Content)

"An eruptive rock quarried 20 miles west of Albany on the western slope of the Cascade Range and which presents an ancient aspect. The composition of this rock is that of a diabase with an admixture of rhombic pyroxene but in its general facies and structure as well as in the character of its alteration products it is closely related to the gabbros. Rocks of the same character, high up in the mountains, are abundant a short distance southwest of Mt. Hood. While it has long been known that the Cascade Range is built up chiefly of recent lavas, it is becoming more and more evident that eruptions of gabbroic and granitic rocks must be admitted as important elements in its construction."

Diller, J. S. Geological Reconnaissance of Northwestern Oregon. U.S.G.S. Annual Report 17 1896

29 (Content)

Mentions briefly the occurrence of basalt and diabase at various points along the coast, at Oregon City and in the hills throughout the Willamette Valley.

Diller, J. S.. Structure and Age of the Cascade Range, Oregon. American Geologist 18:16 1896

30 (Content)

"The Cascades are composed from top to bottom of lavas. Apparently the greatest upbuilding took place during the Neocene and apparently follows no pre-existing ridge of metamorphics."

Diller, J. S. Crater Lake. Journal of Geology 1897

(Content)

31 "Of the igneous rocks he states: "The earlier rocks of the rim are andesites, the later ones, rhyolites, while basalts which are also of late eruption are confined to small aduate cones low down upon the outer slope of the rim."

Diller, J. S. Rosenburg Folio Oregon. US.G.S. Geol. Atlas of the U. S. Folio No. 49 1898

32 (Content)

"Within the Roseburg quadrangle there are several recognized types of igneous rocks. Mentioned in the order of age, beginning with the oldest, they are:

1. Metagabbro
2. Serpentine
3. Dacitic rocks
4. Diabase
5. Andesite
6. Rhyolite
7. Basalt

A complete account of the occurrence is given of these rocks together with extensive petrographic descriptions."

(Area geologically mapped)

Diller, J. S. Educational Series of Rock Specimens. U.S.G.S. Bull. 150:74 1898

33 (Content)

"Saxonite: in extent directly west of Riddle, the seat of deposit of,

Genthite: a nickel silicate of economic importance.

"The rock is a dark yellowish green color of high specific gravity, suggesting that once it was rich in ferromagnesian silicates. It is holocrystallin granular, and composed essentially of olivine and enstatite, with a small percentage of accessory chromite and traces of magnetite. The olivine predominates so that the enstatite forms less than one-third of the mass..... and occasionally shows fine lamelae twinning. Both the olivine and the enstatite are clear and colorless, but may readily distinguished by thin cleavage and optical properties. They are allotriomorphic and do not contain inclusions, excepting the coffee-brown grains of chromite with a small amount of magnetite and fine ferric dust. Notwithstanding the fresh condition of the rock, it is in places completely permeated by a multitude of cracks filled with serpentine resulting from its alteration. The combination of enstatite and olivine would appear to be particularly favorable for the production of serpentine, as it supplies to the other the material needed besides water to make serpentine.

Thus saxonite including the serpentine derived from it, is of particular interest in being the seat of a deposit of genthite, a nickel silicate of economic importance. It is associated with quartz in more or less distinct veins, which, according to Mr. W. L. Austin, who has studied the deposits in the field, and mapped them, extend across the entire area in a northeast and southwest direction. The genthite, like the vein quartz, is of secondary origin and from the fact that the olivine in the saxonite contains nickel, it is regarded as the source of that in the genthite.

Analysis by F. W. Clarke

I. Saxonite
II. Olivine from it.

	I	II
Ignition....	4.41	.57
SiO_2........	41.43	42.81
Al_2O_3.......	.04	
Cr_2O_3.......	.76	.79
Fe_2O_3.......	2.52	2.61
FeO.........	6.25	7.20
NiO.........	.10	.26

Diller, J.S. Bohemia Mining District of Western Oregon Notes on the Blue River Mining Region and the Structure and Age of the Cascade Range.
34 U.S.G.S. Annual Report 20 No. III, 1900

(Content)

"Calapooya mountain: Composed of sheets of lava like the Cascades radiating from their source vents. Dacite porphyries are dominant, basalt found sparingly."

"½ mile southeast of Musick andesites are dominant, with tuffs in eastern part."

Fairly complete petrographic descriptions are given.

"Blue River Region: 45 miles northeast of Eugene near McKenzie Fork

1. Recent igneous rocks
2. Andesites — more siliceous than those of Bohemia
3. Basalts
4. Rhyolites
5. Olivine basalts

Diller, J.S. Notes on the Structure and Age of the Cascade Range with Special Reference to the Localities of Fossil Plants Described by
35 Knowlton. U.S.G.S. Annual Report 20 III 1900

Notes occurrence of hornblende-hypersthene-andesites near Bonneville.

Diller, J.S. and Patton, H.B. Geology and Petrography of Crater Lake National Park. U.S.G.S. Professional Paper 3, 1902

36 (Content)

Gives complete and detailed account of the occurrence of the following rocks at numerous localities. Listed in order of occurrence.

1. Tuffaceous dacite
2. Dacite
3. Basalt
4. Hypersthene andesite

} Rocks of geologically mapped area

"The sequence of ejection supports Idding's proposed theory of Magmatic differentiation and cycle of magmatic activity."

A very exhaustive treatment of the petrography of these rocks is given by H. B. Patton with photomicrographs and drawings of their sections together with chemical analysis by Stokes.

Diller. J. S. Coos Bay Coal Field. U.S.G.S. Annual Report and Coos Bay Quadrangle Folio 73

37

Small outcroppings of Eocene basalt with diabase dikes and intrusives mapped, not petrographically described.

Diller, J. S. Port Orford Folio, Oregon Description of. U.S.G.S. Geological Atlas of the U.S. Folio 89 1903

38

Small irregular areas of basalt, serpentine, dacite porphyry geologically mapped.

Diller, J. S. and Kay, F. G. Mines of the Riddle Quadrangle. U.S.G.S. Bull. 340 1908

39

(Content)

Includes a general account of the occurrence of:

1. greenstones
2. peridotites

3. serpentines

4. granodiorites

5. dacite porphyries

6. augite andesites

Area not geologically mapped.

Diller, J. S. and Kay G. G. Mineral Resources of the Grants Pass Quadrangle and Bordering Districts. U.S.G.S. Bull. 380 1909

40

(Content)

"In the Applegate region igneous rocks are much more abundant than sedimentary rocks and are of comparatively few types, embracing: greenstone,
granodiorite
serpentine
dacite porphyry
augite andesite.

Greenstone: much altered but when fresh and fully crystalline, it is commonly like a gabbro composed essentially of pyroxene and lime-soda feldspar, but it may contain hornblende and resemble diorite, or have ophitic structure and pass into diabase, or be compact like basalt. Most of the greenstone, too, is locally vesicular and this feature, occurring in rock associated with beds of fragmental volcano material, shows clearly that a large part of the fine grained greenstone is of volcanic origin and its relation to the fossiliferous limes stones indicates that volcanoes from which it came were active, some in the Paleozoic era and others in the Mesozoic.

Serpentine: A few irregular masses cut the older greenstones. For the most part they have resulted from the alteration of peridotite or pyroxenite, but some may have come from a basic phase of the greenstone.

Granodiorite:....forms irregular masses and dikes at a number of places. It is composed chiefly of plagioclase feldspar, quartz and hornblende, generally with more or less mica and orthoclase feldspar, with the increase of hornblende it varies in color from a fine grey to a greenish black.

Dacite porphyry: a light colored rock which in composition and origin is closely related to the granodiorite. It forms dikes, and though widely distributed, is not abundant. Some of it is decidedly porphyritic, with phenocrysts of feldspar and quartz.

Augite andesite: a dark colored rock that occurs in a few small dikes cutting all the other igneous rocks as well as the sedimentary rocks up to the top of the Horsetown."

Relative age according to order listed.

Diller, J. S. Mineral Resources of Southwestern, Oregon U.S.G.S. Bull. 546 1914

41

(Content)

Includes an account of the occurrence in an area longitude 123° to 123° 40' latitude 42° to 42° 30' of:

1. greenstones

2. serpentines

3. granodiorites

4. dacite porphyries

5. augite andesites

A general petrographic description is given of those rocks but no attempt was made at detailed mapping.

Diller, J. S. Chromite in the Klamath Mountains of California and Oregon. U.S.G.S. Bull. 725 1921

42 (Content)

"Peridotite--is the dominant rock. A basic igneous rock, includes everything between the extremes, dunite and pyroxenite.

It is the source of all serpentine, making up the bulk of the Klamath Mountains.

Rocks include:

Peridotite:
olivine
pyroxene
enstatite or dialage
magnetite
chromite

Saxonite: Nickel mountain, 3 miles northwest of Riddle containing chromite ore.

Bastite = weathered saxonite

Dunite = weathered saxonite

Region erupted at end of Jurassic, probably."

Diller, J. S. Crater Lake. Journal of Geology 1923

43 (Content)

"Did Crater Lake originate by a volcanic subsidence or by an explosive eruption?" Diller cites an inflow of dacite into the crater.

Diller, J. S. and Kay, F. G. Riddle Folio, Oregon. U.S.G.S. Geol. Atlas of the U.S. Folio
44 No. 218 1924

(Content)

"The igneous rocks of the Riddle quadrangle are of several kinds and differ somewhat widely in age. They occur in irregular shaped areas and in dikes. Some are intrusive, others show undoubted effusive characteristics. In the field the chief types were mapped as:

basalt
dacite porphyry
quartz diorite
serpentine
peridotite
greenstone

The oldest igneous rocks of the quadrangle are the Ancient Rhyolites associated with the May Creek Formation, Paleozoic. Some of the greenstone lavas and possibly some of the intrusive greenstones may also be of Paleozoic age. Next younger are the basaltic lavas, included on the geologic map in the greenstones, and rhyolitic lavas of Jurassic age. Of the intrusive rocks, the intrusive phases of the greenstones are the oldest, then come in turn the peridotite, the quartz diorite and the dacite porphyry and finally the basalt, which cuts the greenstones, the quartz diorite and the Horsetown of Cretaceous age. All the intrusive rocks, except the basalt and the possibly Paleozoic greenstone appear to be of late Jurassic or early Cretaceous age. The basalt is probably related to the volcanic rocks of the Cascade range and if so is of Tertiary age. (Area geologically mapped.)

The petrography of each of the above mentioned rocks is given in detail together with chemical analyses."

Dutton, C. E. Geologic Investigations in Oregon. U.S.G.S. Annual Report 7 101-2, 1886

45 (Content)

"Lavas in Cascades are almost wholly of basic types, andesite and basalt. Andesites sometimes turn to dacites but in general they approach a basaltic which brings them near andesites. Olivine is never abundant in the basalts while the bisilicates of the andesites are usually hypersthene and augite though hornblende is not uncommon."

Dutton, C. E. Crater Lake and Head of Willamette. U.S.G.S. Annual Report No. 8, part 1, 1889

46 (Content)

Includes general account of basalt fields on and to the north of McKenzie pass. "There are large masses of Obsidian, many of which present those sperulitic concretions which are so characteristic of the acid lavas of Yellowstone Park."

Notes occurrence of Rhyolite and compares rocks here to those of the southern Cascades.

"Southern Cascades--true andesites usually hypersthene andesite, less frequently with hornblende or augite.

1. True basalts are of a more basic type and everywhere forms bulk of Cascade platform.

2. Rhyolites and dacites are the younger and form some of the dominant piles which stud the platform.

3. Youngest of all are heavy basic basalts.

Notes that largest Rhyolite field is in the Mutton Mts.

Emmons, A. G. Notes on Mt. Pitt, Oregon. California Academy of Science Bull. 1 No. 4 1886

47 (Content)

"There has been only one phase in the volcanic activity of Mt. Pitt and the rock composing it is all basalt..... The more recently formed rock near the summit, is more porphyritic in character and shows much vesicular inflation while the rock forming the lower part of the mountain and the older flows is compact and fine grained. The former, though varying somewhat in color, has usually a dark bluish grey paste, thickly dotted with minute white crystals of feldspar, and dessiminated through it, larger crystals of pyroxene, with occasional grains of olivine..... Under the microscope these rocks show a microcrystalline groundmass, filled with clear porphyritic crystals of plagioclase feldspar, pale green and brownish colored pyroxene, fresh and unchanged, and some roundish grains of olivine, sometimes quite fresh, at others edged with a thick dark border so characteristic of this mineral. In the more vesicular specimens, there is more groundmass composed of lath shaped crystals of feldspar and some of glass, sprinkled with minute grains of magnetite, while in the finer grained specimens, the rock is more evenly crystallized and the groundmass is less prominent. The feldspar is all plagioclase, no orthoclase having been observed. The pyroxene mineral in these rocks consists of both hypersthene and augite, but the hypersthene rather predominates. Its determination as such rests upon its pleochroism and its orthorombic character, as shown by the extinction of light parallel to its principal axis. This occurrence of hypersthene as a rock constituent, adds another to the already widespread range of this mineral, which has suddenly jumped into prominent existence in such a remarkable manner.

Analysis
I. Younger vesicular rock:
II. Compact variety:

	I	II
SiO_2......	55.89	56.33
Al_2O_3.....	20.01	20.19
Fe_2O_3.....	1.77	7.16
FeO.......	4.72	
MnO.......	.06	
CaO.......	8.12	8.74
MgO.......	4.57	2.53
Na_2O......	2.66	3.81
K_2O.......	2.29	1.38
Ignition..	.19	
	100.28	100.14

The low percentage of silica, and the constant presence of olivine, would seem to keep this rock within the line separating basalt from hypersthene-augite-andesite."

Fisk, H. N. The History and Petrography of the Basalts of Oregon. University of Oregon, Thesis, 1931

48 (Content)

The first part of this work is devoted to a very thorough review and discussion of the literature on the basalts of Oregon in general with particular attention to the Columbia River basalts.

"The purpose of this review is to provide a a means for making the literature easily accessible and for correlating field data recorded in the literature with the results of the laboratory and field ($1\frac{1}{2}$ seasons) of the writer. A map, Plate I, shows the areal distribution and extent of all the basalts and the sources of information.

The basalts are divided into six main divisions according to their age and are subdivided into different periods in which they occur."

"In the second portion of the thesis, the writer has attempted to classify approximately 500 basaltic rocks which have been collected from various parts of the state by men working on research problems under the direction of Dr. E. T. Hodge since 1924. Other than their localities and formations in which they occur, these basalts have had no definite grouping. They represent, however, a complete collection of basalt types of north central Oregon, the Cascade Range in the northern part of the state, as well as a few specimens taken from the western side of the Cascades as far south as Oakridge. The classification also includes specimens of the Ten Mile basalt formation of the Coast Range and a few random specimens with definite localities collected by different workers previous to 1924."

The above mentioned types have been again subdivided on a petrographic basis. Petrographic descriptions of these types appear with photo-micrographs but are too numerous to be given in this paper.

Fisk, H. N. Significance of Three Generations of Plagioclase in an Andesite-Basalt flow. Bull. Geol. Soc. America p. 442 1934

49 (Content)

A systematic study was made of oriented thin sections from samples collected at three foot intervals throughout a 150 foot porphyritic andesite-basalt flow from Rogue River Valley, southwestern Oregon. The evidence of intratelluric and two later stages of plagioclase and the criteria for the recognition of these three stages are presented. The type and mineral associations illustrate fractional crystallization, reaction between the solids and fluid to effect, by successive stages, an enrichment of the residual liquid in iron, sodium, and silicon oxides and impoverishment of the liquid in calcium, magnesium, and aluminum oxides. The evidence upon which these generalizations rests is chiefly petrographic.

Fisk, Harold N. Differentiation in Columbia River Basalt.

50 (Content)

"A glassy basalt flow, sixteen feet thick from Grand Coulee, Washington was sampled at one foot intervals. Each specimen was sectioned both parallel to and normal to the surface of flow. Work to date shows the holocrystallin portion of the flow limited to the lower two feet where there is a concentration of magnetite and olivine. Above this, augite and magnetite vary inversely with the percentage of trachylyte which is frequently rendered opaque by these minerals in a finely divided state. The percentage of plagioclase is remarkably constant throughout the flow, with a tendency toward the concentration of the more basic plagioclase in two definite horizons. Thin sections normal to the flow surface show 15% less total area and 30% more basal sections of plagioclase than those cut parallel to the surface of the flow.

In view of this internal variation in a single flow, it is unsafe to base conclusions regarding other flows without care as to position and orientation of the samples taken. At the same time, work now in progress on an olivine free, glassy basalt area of the same Columbia River lava field, at Tygh Valley, north central Oregon, shows a distinct tendency toward increasing basicity in successive eruptions. Thin sections of sixteen super-imposed flows show a progressive change from andesine basalt at the base to basic labradorite-anorthite basalt at the top of the series."

Fairbanks, H. W. Notes on the Geology of the Three Sisters, Oregon. Amer. Geologist 27 1901

51 Notes volcanic activity of the Three Sisters region to be past glacial.

Von Foullon, H. B. On Riddles, Oregon. Jahrbuch K.k. Geol. Reichsanstalt Vol. 42 Vienna 1892 223.

52

(Content)

The minerals, their associations and their probable origin are described. The ores are thought to have resulted from the decomposition, by superficial weathering of the country rock called harzburgite. The process of alteration are discussed fully.

Fraser, D. M. The Petrography of a Section of the Oregon Cascades from Oakridge to Cresent. University of Oregon, Thesis. 1926

53

(Summary abbreviation)

"...... A study of the flows in the field and the rocks in thin section shows that the flows from Oakridge to McCredie Springs are successively less basic. They diverge more and more from rocks of basaltic nature and approach more closely pure labradorite rocks. Diabases, ophites, etc., without definite relations of this kind are found over the remainder of the region......"

"Summary of the Magmatic sequence as evidenced by rock formations.

1. Magmatic excretion as flows of rock masses very rich in augite, other constituents being labradorite and magnetite.

2. The percentage of augite became less, but was still present in a very noticeable amount.

3. Flow rocks in which the augite percentage is low, and labradorite greatly predominates.

4. Material was ejected with explosive violence by the pressure of gasses beneath. This material.

had (1) labradorite crystals and crystal frgments as its chief constituent, with occasional crystals of augite, or (2) was composed of volcanic glass fragments.

5. A series of ophite and diabase flows.

6. Excretions in which hypersthene replaced augite followed.

7. Explosive material.

8. Late basaltic flows.

Richthofen's[1] sequence of volcanic rocks based on observations in Hungary, Transylvania, and in the Sierra Nevadas is:

1. Propylite (Includes phonolite and dacite)
2. Andesite
3. Trachyte
4. Rhyolite
5. Basalt

This succession might be stated as:

1. Intermediate--acidic
2. Intermediate
3. Acidic
4. Acidic
5. Basic

In the Three Sisters region the succession was:

1. Basic
2. Intermediate
3. Acidic
4. Basic "

In the region of Crater Lake according to Diller and Patton[2] the order was:

" 1. Intermediate
2. Basic and intermediate--acidic

These, however, do not include all the rock types and therefore would not be expected to show all the stages."

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1. Richthofen, Ferdinand Principles of the National System of Volcanic Rocks. 1867
2. Patton, Geology and Petrography of Crater Lake National Park U.S.G.S. Prof. Paper No. 3

The rocks of the Diamond Peak region also do not show a complete sequence, being:

1. Basic
2. Intermediate--acidic
3. Intermediate
4. Intermediate--basic

The following list of rocks have been petrographically described and appear with photomicrographs. Also tables of calculated mineral percentages.

Thin Section No.

F-67..................Olivine diabase
F-64..................Augitite labradorite
F-63..................Labradorite rock
F-61..................Labradorite rock
F-60..................Labradorite rock
F-59..................Labradorite rock
F-52..................Basic vitrophyre
F-50..................Olivine dolerite
F-49..................Labradorite rock porphyry
F-47..................Labradorite rock
F-45..................Olivine diabase
F-42..................Olivine dolerite
F-38..................Diabase
F-37..................Olivine diabase
F-35..................Olivine diabase
F-34..................Olivine dolerite
F-32..................Olivine ophite
F-28..................Olivine diabase
F-24..................Hypersthene basalt
F-21..................Hypersthene basalt;(augenite)
F-12..................Olivine ophite
F-8...................Olivine ophite
F-5...................Olivine dolerite
F-3...................Olivine diabase
F-2...................Olivine basalt

(Structure)

"The Cascades of central Oregon are built of nearly horizontal lava layers which show little or no folding."

Section made from Oakridge to Cresent, probably hypothetical for the most part.

Fuller, R. E. Obsidians of Oregon. Journal of Geology. 35:570 1927

54 (Content)

"The red and brownish opaque colors frequently observed in black obsidians have been proved to be due to the oxidation of the small iron content (Iddings). A microscopic examination of specimens of obsidian from the Glass Buttes and Beatty's Butte in south central Oregon furnished evidence of two types of mechanism by which this oxidation occurred. The observation was strengthened by field observation of the very recent acidic flow on Newberry Mountain about twenty-five miles south of Bend, Oregon........."

"By this interpretation, the author endeavors to show the likelyhood that the alternate concentration of volatiles, which is probably responsible for acidic lamination, may logically be caused by the mechanics operative in the movement of a very viscous lava, and not only by the mere fluxion of a volatiles."

"Irregular pigmentation is due to the oxidation and the subsequent re-fusion of flow breccias. In banded varieties, the oxidation occurs in minute tensional cracks developed by the differential rate for flow between the successive layers of lava. This same factor may be the cause of the laminations in acidic lavas."

Fuller, R. E. Evidence of the Gravitational Accumulation of Olivine During the Advance of a Basaltic
55 Flow. Bull. Geol. Soc. of Amer. V. 42 P. 190 1931

(Abstract)

"In southwestern Oregon, on the eastern scarp of Steens Mountain, a basaltic flow shows a basal concentration of olivine grains, which average over 1 millimeter in diameter. The flow is approximately 30 feet in thickness. The upper zone, which is gree from olivine, has a thickness of approximately 10 feet, while the enriched zone is about twice that size.

"Since the chilled base of the flow, with a relatively low concentration of olivine, presumably represents the initial composition of the basalt, the impoverishment of the lava forming the upper zone can account for only one sixth of the concentration beneath it. The enrichment is therefore attributed to the settling of olivine during the advance of a very fluid flow. Due both to basal chilling and to the concentration of the coarse grains, the viscosity of the lower zone would have been increased, while the more mobile upper zone, from which the olivine was continuously sinking, would have continued to advance. The accumulation of the olivine phenocrysts might thus be somewhat analagous to the deposition of sediments in a river."

Fuller, R. E. Aqueous Chilling of Basaltic Lava on the Columbia River Plateau. Bull. Geol. Soc.
56 America Vol. 42. P 301 1931

(Abstract)

"In Washington in the vicinity of Moses Coulee, palagonitic breccias and ellipsoidal lavas occur as the basal phase of numerous flows. The breccias which range up to 50 feet or more in thickness, contain inclined elongate masses of basalt, which are either slaglike or ellipsoidal. They are invariably coated with a thick selvage of transparent basaltic glass. This inclined mass dips almost uniformly at about 30°. The larger pillows tend to flatten in contact with the normal lower flow. In settling, their surfaces develop remarkable tensional features.

The advance of a very fluid flow into a shallow body of water is considered to have resulted in the granulation of the lava in a manner similar to the quenching of slag. Over this mass the flow would have poured in thin tongues. It would thus build foreset beds of granulated lava and inclined streaks, while the flow would have gradually advanced on this accumulation as if on dry land. The palagonization of the breccia is attributed to the retention of the stream by the presence of the overlying flow.

The basal phase of some flows is formed almost entirely of ellipsoidal lavas, which may attain a thickness of over a hundred feet, Although the pillows are predominantly horizontal, the exposures show some inclined accumulations of palagonitic breccias.

Proving a mode of origin similar to that of the foreset bedded type. The formation of the pillows is attributed to the higher viscosity of the advancing lava, permitting it to drop into the water in gigantic globules, which, due to gravity, would settle toa roughly horizontal position. These masses in the course of formtion may have been subdivided by the explosive generation of steam.

In the above instances, flows have come into contact with shallow lakes. In Douglas Creek a tributary to Moses Coulee, a palagonite breccia appears to have been formed by a very fluid lava becoming immersed in a superfluity of water in a lake, which contained Miocene sediments. In this same valley, later flows show the incipient development of ellipsoidal surfaces in contact with moist sediments. This variety of pillow structure is attributed to steam action."

Fuller, R. E. Tensional Surface Features of Certain Basaltic Ellipsoids. Jour. Geol. Vol. 40 P. 164 1932

57

(Abstract)

"The subaqueous distention of the surface of ellipsoidal masses of basalt is shown to have resulted in crustal displacement and, therefore, in the formation of remakably regular angular corrugations. Banded joints cracks are explained by their periodic advance owing to the surface contraction of the pillow during rapid solidification."

Gilluly, James Lingren Volume Ore Deposits of the Western United States. A.I.M.E.

58 (Abstract)

"Blue Mountain District: The gold deposits of

the Blue Mountains are distributed over a belt about 100 miles by 140 miles, extending from the Snake River to Canyon City. They are contained in carboniferous argillite, Triassic slate, and greenstone, in pre-Jurassic gabbros and in quartz diorite masses of post-Jurassic age to which they appear to be genetically related."

59 Gilluly, James Replacement Origin of the Albite Granite Near Sparta, Oregon. Bull. Geol. Soc. of America Vol. 42 P. 188 1931

(Abstract)

"The albite granite near Sparta, in the foothills of the Wallowa Mountains of eatern Oregon, is thought to be a product of albitization and partial silicification of an earlier quartz diorite. These changes are related to magmatic and post magmatic replacement of the almost completely solidified quartz diorite by solutions derived probably through filter pressing from lower horizons of the same mass. These solutions were guided at least in part and probably entirely by brecciated zones in the quartz diorite.

Mineralogical changes effected were: The replacement of the andessine and subordinate orthoclase of the quartz kiorite by albite, the replacement of some of the common green hornblende by the soda amphibole, hastingsite, and the introduction of large quantities of dark;blue quartz. The habit of this quartz is decidedly different from that of the normal granites in that the blue quartz occurs in regular nests and veinlets penetrating the rock in many directions. Most of the dark minerals have been removed. Myrmekite and micrographic textures are common in the albite granites, though absent from the unaffected quartz diorite.

That the albitization and other changes of the albite granite have resulted from later reactions on the quartz kiorite is shown by field relations, microscopic study, and chemical analyses. The process is considered analagous to that of large-scale pegmatization.

The rocks are all of presumable Mesazoic Age."

60 Goodspeed, G. E. Some Effects of the Recrystallization of Xenoliths at Cornucopia, Oregon. Amer. Jour. of Science 20:145 1930

(Content)

"At Cornucopia the main mass of the intrusive is granodiorite. It is a light colored rock, and for the most part medium grained in texture, altho in some places it may be somewhat porphyritic. Some border facies are distinctly gneissic. The usual mineral composition is approximately:

Plagioclase	60%
Quartz	20%
Orthoclase	10%
Biotite and Hornblende	10%
Magnetite	Minor amounts
Apatite	
Pyrite	

Zoning is characteristic of the plagioclase. The inner zones are more calcic in composition and are also more turbid, the outer are clear. Some of the hornblende is practical y replaced by biotite, and this mineral is slightly altered to chlorite. Some of the smaller stock like masses contain no chlorite. In some of these bodies quartz is very abundant, constituting nearly 30% of the rock.

Associated with the major intrusive mass are the usual satellitic dikes. At Cornucopia while porphyries and aplites predominate, there are a few granophyres and pegmatites as small dikes and lenses.

It is commonly supposed or taken for granted that dikes, such as porphyries and aplites, represent direct off-shoots of the intrusive mass and may be considered, in fact, as samples of the progress of the crystallization of the molten magma. At Cornucopia the relative age of the dikes, in general beginning with porphyries followed by aplites and ending with quartz veins, is what might be expected from theoretic assumptions. However, in this vicinity there are some exceptions to this order. Most of the porphyry dikkes contain plagioclase much more calcic than the feldspars of the granodiorites. A satisfactory explanation for this pecularity was not available until the relations of a certain porphyry dike were studied".....(Dike relations discussed at length).

"At Cornucopia it seems probable that most of the porphyry dikes owe their origin to the contamination of the granodiorite magma or its volatile rich facies with recrystallized and disintegrated xenolithic material. The association of aplitic and pegmatitic dikes and veinlets with contact breccias suggests that recrystallization effects may have been a factor in their formation. It is evident that some of the material filling some of the quartz and hornblendic veinlets has come directly from reaction rims which surround many xenoliths. The initiation of the larger quartz veins may be related to contact phenomena, but their complete development is distinctly different from the other satellitic bodies."

Goodspeed, G. E. Effects of Inclusions in Small Porphyry Dikes at Cornucopia, Oregon

61 (Abstract)

"Certain porphyry dikes related to a batholithic intrusion in the Blue Mountain area of northwestern Oregon contain irregular segregations of magmatic residuals and veins which are believed to have been caused by the action of the dike magma upon the schist inclusions. Many large scale occurrences similar to this have been recorded, but it is believed that the small size of this magmatic system, dikes less than 2 feet in width, makes it a rather noteworthy occurrence." Relationship discussed at some length.

(Conclusion)

"Aside from those of denteric origin, the dike appears to contain no minerals different from those formed by the undisturbed crystallization of the magma. Therefore the amounts and peculiar forms produced by the magmatic residuals are apparently the effect of the absorption of the schist inclusions."

Goodspeed, G. E The Mode of Oigin of a Reaction Porphyry Dike at Cornucopia, Oregon. Jour. of Geol. 37 P. 158 1929

62

(Abstract)

"A small stock-like mass of quartz-diorite intruding feldspathetic schists reacted with schist inclusions producing plagioclase phenocryst more calcic than those indigenous to the uncontaminated magma. All stages in the development of these crystals from their initiation in the xenoliths to their occurrence as phenocrysts in the hybrid magma are clearly shown. The irruption of this magma into a fissure formed what is termed a "reaction porphyry dike."

Embodies a full discussion of the petrology of this occurrence.

(Conclusion)

"This occurrence, as well as many others, such as the syntetic porphyry at Porcupine described by Whitman suggests that certain porphyries may be due to reaction and replacement processes, rather than to either the regular or the interrupted fractionation of a magma."

Handley, H. W. Certain Rocks of the Cascade Mountains. University of Oregon Thesis 1931

63 "General Observations: It is very difficult to segregate these rock types with reference to occurrence, but it may be said that in general, the rocks of the Cascades are more undersaturated at low elevations and more saturated at higher elevations, the youngest being oversaturated. There are a few exceptional cases.

Cascade rocks near their eastern contact with the upper part of the Dalles formation are olivine basalts, which contain rather large percentages of olivine and magnetite.

Basaltic rocks at low elevations, which have been confused with the Columbia River basalts, are found to be undersaturated types belonging to the Cascade series.

There seems to be no definite sequence, in the Cascade series, of pyroxene and hornblende andesites. Augite is by far the most common ferromagnesian constituent, hypersthene is found in a large number of specimens but seldom predominates over augite. Hormblende is not as common as hypersthene, but is often found with hypersthene. There are a few cases where hornblende is not accompanied by hypersthene.

Olivine is a more common constituent of these rocks, than has been recognized in the past by Williams and Diller. It is, however, chiefly confined to the undersaturated types at low elevations.

Hypersthene and olivine are seldom found in the same rock, but there are a few examples in this collection. The percentage of one or the other is generally low.

Magnetite occurs in all specimens, varying from a mere trace to as much as 25%.

Apatite is present in very small amounts and always occurs as inclusions in hypersthene.

Hypersthene and hornblende andesites are the most abundant rock types of the Cascade Mountains proper."

Contains petrographic descriptions and photomicrographs of the rocks discussed. Tables are included of the mineral percentages and certain observed relationships.

Hampton, W. H. Post-Mortem on Oregon's Famous White Metal Mystery. Engineering and Mining Journal
64 125:1061 1928

(Content)

"I feel that I am fully warrented in expressing the preliminary opinion that the metals represented in the samples were introduced by human agencies, accidentally or otherwise either before or during the processes by which they were purported to have been extracted from the rock that was supposed to contain them."

Hershey, Oscar H. Age of Certain Granites in the Klamath Mountains. Jour. Geol. 9 1901

65
(Content)

"Small batholiths and dikes of granite, quartz, mica, diorite, and intermediate types are known to occur at various places in the Klamath region, but in areas quite subordinate in extent to those of the metamorphic rocks in which they have been intruded. The age is known to be between Carboniferous and Chico, given as upper Jurassic and is classed as an outlier of the Sierra."

Hodge, E. T. Geology of Mt. Jefferson. Mazama, Dec. 1925

66 (Content)

A complete account of the vulcanology and glacial history of the Mountain. Vulcanism started in the Oligocene and continued through to the Plistocene with the greatest upbuilding coming in the Pliocene.

"Mount Jefferson was born with the initiation of Pliocene vulcanism. From several orifices mugearites and keratophyric lavas issued to the surface of that portion of the Cascades, where Mt. Jefferson was destined to stand, as flows."

These rocks being intruded up through the Miocene basalts. Jefferson flows and relationships are further discussed.

"Petrography:

The color of these Pliocene mugearites, keratophyres, olivine oligoclassites, and olivine laurvikites varies from grey to light grey to pale blue. When the pale blue rocks are moist their color is almost sky-blue. The iron, which these rocks contain, leaches out easily and forms a thin paint of pink hematite on the outside. Large slopes composed of these rocks, when moist, afford great splashes of beautiful blue and pink colors.

The rocks vary in size of grain from those wherin the minerals cannot be seen with the naked eye, to those which are quite coarse-grained. The fine grained rocks show a slight mottling. Porphyritic varieties are quite common in which colorless phenocrysts of plagioclase make up the phenocrysts. In the coarse-grained porphyries, the phenocrysts are tabular but in the fine grained porphyries the phenocrysts are long, narrow, glistening blades. Some of the porphyritic mugearites and ketophyres show shiny black to green crystals of augite.

The coarse grained varieties are olivine oligoclasites and olivine laurvikites. They contain grains ranging from one tenth of an inch in diameter. The rocks, where fresh, are light grey and contain pale muddy green spots throughout. When weathered they are a dull greenish grey. These rocks have numerous intermeshed, prismatic, glistening, striated crystals of plagioclase. Within this matrix of plagioclase are rounded nodules of bottle green olivine. They are holocrystallin and even-grained. The plagioclases show strong flowage texture. They consist of about 20% of zonal orthoclase which make up the larger grains, 30% of oligoclase and andesine which are long prismatic crystals and which give the coarse rocks their white color. About 20% is augite with a little acmite. When large these augite and acmite crystals are black, shiny prisms; olivines makes up about 30% in the laurvikites which is displaced by augite in the oligoclaseites. This olivine in hand specimens appears as bottle green grains or rusty spots. Accessory minerals are pyrite, magnetite and apatite. Limonite and hematite are the secondary minerals which stain and give the rock its pink color. Most of these rocks are fresh and have but few secondary minerals.

Porphyritic varieties of the olivine laurvikites and olivine oligoclasites are very common. Thin sections show that in these the oligoclase is displaced in part by andesine and the orthoclase is reduced to about 10%. In these the augite replaces much of the olivine. The larger feldspars are bunched with the augites and give the rock in hand specimens a culumaphyric texture.

The fine-grained rocks are so dense that in hand specimens the minerals are not easily determined. Under the microscope the fine-grained rocks are shown to be keratophyres and mugearites. They are all holocrystallin, very fine-grained with extreme flowage texture. They consist of orthoclase oligoclase and augite. The orthoclase may amount to 30% and shows zonal bands and good twinning. The oligoclase makes up about 60% of the rock and occurs as very prismatic crystals. The augite amounts to about 10% which, in thin sections, is colorless. Large augites are pale green. Accessory minerals are magnetite and apatite. There is a little secondary kaalin. These rocks, if fresh, are pale green due to the augite. If slightly weathered, they are pink due to secondary limonite and hematite."

Hodge, E. T. Mount Multnomah (Ancient Ancestor of the Three Sisters) University of Oregon Pub. 1925

67

(Content)

"Summarized History of Mt. Multnomah"

The history of Mt. Multnomah will help to correlate the evidence of its former presence. Oregon's greatest mountain was born in stage "II" or the Oligocene when an eruption started along the Cascade fault. During all of this period a tuffaceous cone, remnants of which are found in the fragmental rocks, was piled up. Beginning in the middle of the Miocene and continuing into the late Miocene, stage "III" an enormous flood of basic lava poured out. As a result of this intense volcanic activity, Mount Multnomah was built into a gigantic cone over 15,000 feet high and with a base extending from the vicinity of Belknap Springs on the west to Three Sisters, on the east to beyond Mt. Washington on the north and to Elk Lake on the south. The lavas from the crater poured out far beyond the base of the cone in all directions for seventy or eighty miles. On the west these lavas reached the western edge of the Willamette valley. On the east, these lavas now lie buried beneath later volcanic flows, through, in some of the deeper canyons, such as that of the Deschutes, these lavas may be seen. Wherever found they show an outward dip from the axis of Mount Multnomah.

At the close of the Miocene the entire top of this mountain either collapsed or was blown off. If a collapse, it was due to the inability of the earth beneath the cone to support the enormous weight. The top of this mountain might have sunk into the mass of liquid rock below in much the same manner as the stone neck of a jug would sink were it broken by a down crushing weight. The cause of the subsidence was the cessation of upward pressure, which had forced the lavas to the surface. The support was only that which could be afford by the subjacent rocks, and since this was liquid rock, it is evident that with the cessation of explosive pressure, the top of the mountain would drop into the resurged liquid magma below.

The top might have been blown off much as was that of Krakatau. Since practically all the world's great calderas have been due to decapitation by explosion, we may conclude that Mt. Multnomah lost its top by such a catastrophe. Whether due to caving in or to an explosion, the destruction of the top of the mountain created a circular fault around its entire edge. The location of this fault was a diameter of about eight miles. It is thus evident that the caldera was of gigantic proportions.......

In the early part of stage "IV" or the beginning Pliocene, streams working their way headwards from the east and west eventually cut into the walls of this caldera. When these streams cut their channels low enough, they afforded perfect outlets which drained completely. If one could have visited this area away back in the distant Pliocene, he would have found a high mountain meadow surrounded on all sides by sheer walls rising three or four thousand feet and cut through midway between the four points of the compass by narrow canyon walls.

In the middle Pliocene volcanic activity was again renewed, the result of movement along the Cascade fault. Two new volcanoes were formed within the caldera. The Elder Middle and Elder South Sisters--the close of the Pliocene produced a dissection of these two peaks to a state of maturity.

Continued upward movement again revived vulcanism with the result that the present Middle and South Sisters, Black Crater, Mount Scott, Bachelor, and the whole chain of peaks along the Cascades were developed. A continuation of this uplift brought about flaciation in the Ice Age, or Stage "V". The sinking down of the Oregon fault block which brought about the close of glaciation reopened the Cascade fault and revived vulcanism again. The vulcanism of this last period gave birth to Belknap, with its great sea of lava and the smaller flows around the base of the South Sister."

Hodge, E. T. Structural Features Displayed in the John Day and Deschutes River Canyons. Bull.
68 Geol. Soc. of America 40:167 1929

(Abstract)

"This will describe investigations along the John Day and Deschutes rivers which reveal several major folds in the Columbia River lava and other formations. These folds have been traced from the John Day to the Deschutes River canyons and thence into the Cascade Mountains. Fossils stratigraphic succession, and continuity of formation and structure display and column extending from the Cretaceous to the Recent. As a result of this discovery a new large area of fossiliferous John Day in the Deschutes Canyon and a new area of Cretaceous lying to the last of the Deschutes Canyon has been discovered."

Hodge, E. T. Structure of the East Side of the Cascade Mountains. North West Science 1930
67
(Content)

"Contrary to common belief, the Columbia River Basalt formation does not cover all, nor a large part of eastern Oregon and does not lie on a true plateau. It is to be doubted if it coveres even 50% of that area. Where it does form the main cover it is folded, warped and faulted. Its absence fortunately, exposes in part the basal structures of eastern Oregon......

....Several of the Basalt formations are much younger than the Columbia River Basalt formation. The Columbia River Basalt of eastern Oregon has, at last, been traced continuously to the Columbia River where it is found to be equivalent to one, but not all of the basalt formation exposed there."

Further notes on Cascade structures.

Hodge, E. T. Composition and Structure of Cascade Mountains in Central Oregon. Bull. Geol. Soc. of Amer. 1930

70

(Abstract)

"The Clarno, John Day, and Columbia River Basalt formations were traced to the Canyon of the Deschutes River, where broad open folds and mature surfaces pass under the Cascade Mountains.

On the west side pyroclastics, similar in composition relationships and structure to the John Day formation, were found and traced to the Willamette Valley where they contain Oligocene fossils. The Miocene Columbia River Basalt formation reappears just west of the divide and forms a naturely dissected plateau extending to the Willamette Valley. It holds the subsequent Willamette River in place on the soft eastward dipping Oligocene tuffs.

The pliocene Mt. Jefferson formation, composed of andesitic and trachytic rocks, cuts the older formations especially near the divide and fills the older valleys. It forms the line of high peaks at 120° 45' longitude and covers the eastern surface for at least 12 miles.

The black crater formation underlies glatial drift, covers most of the eastern surface with basalt flows or high volcanoes, and passes under the Madras formation.

The Columbia River Basalt, Mount Jefferson, and black Crater formations all dip gently eastward.

Pleistocene glacial deposits extend from the divide for 25 miles west and 10 miles east.

The Madras formation, probably post-Pleistocene consists of several basalt flows and interflow lake and torrential beds. It lies absolutely flat and covers an immense area north of Bend, east to Prineville, and extends as embayments into the valleys of the Cascades. Flows higher in the Cascade Mountains may be of the same age and origin.

The Crooked River formation partially fills great canyons cut in the Madras formation and has been cut into canyons. In the high Cascade Mountains the drainage has been deranged by the recent lavas.

The Cascades Mountains to the north and to the south, in California, have more complex structures and composition. This area merges into one just to the south, where it appears that a simple pile of late tertiary lavas fills a sag across the Cascade axis. In both areas the structure suggests a block fault dipping gently to the east."

Hodge, E. T. Columbia River Fault. Bull. Geol. Soc. America. Vol. 42 923-984 1931

71 (Introduction)

This paper deals with the heavy Miocene lava flows, known as the Columbia River Basalt, which cover a large part of Oregon and Washington; but more particularly with that part of their area along the boundary between those two states, where the basalt was in Pliocene time folded in strong anticlines, trending and pitching southwest in the Cascade Mountains and faulted in a long, east-west trough just east of the mountains. The trough, here called the Maryhill trough, was formed by a gentle down-bending of the lava so that its surface, called the Shaniko surface, slants gently northward to a strong, south-facing fault-scarp, from 3000 to 3500 feet high and about 80 miles long.

The Pliocene Columbia River took a consequent course along this trough; thus guided, it ran beyond the entrance of the deep canyon which it has since then trenched across the anticlinal folds of the mountains and so reached a sag in the mountain belt, probably related to the southwest pitch of the anticlines. It will be shown that the Pleistocene eruptions of the 12,000-foot cone of Mount Hood, between the sag and the canyon, formed a high barrier in the sag; that a long Pleistocene lake, called Lake Condon, was then formed in the Maryhill trough east of the volcanic barrier; that the lake rose until at an altitude of 1,900 feet, it overflowed a col determined by the overlap of the north-sloping lava flows (Cascade formation) and the associated detrital deposits (Dalles formation) upon the easternmost of the southwest-pitching anticlines in the mountain highlands. Thus the Pliocene Columbia River was extinguished by a volcanic barrier and replaced by Lake Condon, in which silts covered by gravels (Arlington formation) were laid down; but the river was re-established in Pleistocene time when the lake, spilling over the col, ran across the mountains along a course consequent on their highland surface and western slope. Part of its course was soon superposed through the Cascades and Dalles formations on the underlying basalts; and as the magnificent canyon of the present river was thus eroded through the Cascade Mountains, Lake Condon was progressively drained until the river took its place along a course consequent upon the slopes of the Arlington beds in the Maryhill trough, through which it was soon superposed on the underlying basalt, in which it cut a trench of moderate depth...

Columbia River not an Antecedent Stream.

Previous writers have assumed that the Columbia River followed an Antecedent Course through the Cascade Mountains. If this theory be true, then the Ortley anticline must have been slowly upraised while the Columbia River maintained its course. The writer offers evidence in this paper that the Ortley anticline is older than Columbia scarp, and the latter is older than Columbia River. Hence Columbia River is younger than Ortley, the first major fold that the Pleistocene river crosses."

The occurrence of the evidence referred to in the foregoing discussions is fully treated.

(Conclusion)

"The evidence presented in this paper supports a new theory as to the origin of the lower Columbia River. The new explanation contrasts sharply with the old. The river is not an ancient stream that has maintained an antecedent course over large folds in the basalt and across the many obstructions placed in its path. On the contrary, it is a young stream, vigorously carving a new canyon in a recently acquired course. Its history is not a simple one. Its earlier predecessors were several in number and consequent on surfaces developed by faulting and folding. Later dammed, ponded and integrated with its eastern tributaries, it resumed a new consequent course at a high level. The Pleistocene Columbia River has in a relatively short time cut a deep and wonderful canyon, superposed into the great folds of basalt, across the Cascade Mountains."

Hodge, E. T. Progress in Oregon Geology Since 1925. University of Oregon Publication. Eugene, Ore.

(Content)

A brief sumation of the literature and ideas concerning Oregon geology plus a bibliography of Oregon geology from 1925 to 1931 inclusive.

"Before 1925 the Cascade Mountains were considered to be formed of Miocene and early Pliocene lava flows that had been highly deformed and in late Pliocene time eroded to a peneplain. The Cascade peneplain was considered to have been elevated, eroded in the Pliocene and glaciated. The Miocene rocks were considered to be olivine basalts and the Pliocene rocks to be hypersthene andesites. Later investigations have shown that the Oregon Cascade Mountains are divisable into two portions, the southern mountains are related to the Siskiyous of northern California and the northern are related to the southern Cascade Mountains in Washington. No recent work has contributed any new facts to the southern Cascade Mountains. The northern Cascade Mountains are now known to date from Eocene to Recent. Their older formations can be traced into eastern Oregon and into the coast range and only the Pliocene and later rocks are local. The Cascade Mountains, therefore, are a physiographic unit formed by a pile of lavas. The Deschutes River on the east and the Willamette River on the west subsequent to the later lavas have somewhat isolated the Cascade physiographic unit. The writer has found Eocene-Clarno forms of eastern Oregon in the Santiam Valley and Eocene Umpqua sandstones of the Coast range in the Clackamas Valley, and these two occurrences are the oldest rocks to be found in the northern Cascades. Gently folded oligocene pyroclastics lie unconformably upon the Eocene and were little eroded before the outpouring of the Miocene basalts. On the Oligocene beds lie the folded and faulted Miocene olivine-free basalts. The folds and faults differ in no way from those of eastern Oregon and were the later formations removed from the Cascade Mountains, the "plateau" of eastern Oregon would extend with no fundamental change to the Willamette Valley. These Miocene basalts were never peneplained and only near buried valleys were they even eroded to the stage of late maturity. The slightly eroded Miocene basalts were buried by pyroclastics and later by lava flows of Pleistocene Age and these, in turn, by lava flows and pyroclastics of Recent Age. Over large areas the Pleistocene and Recent formations may have participated in a general tilting involving almost the entire state, but no where has evidence been found that they have suffered local folding. They consist of olivine basalts, olivine andesites, sub-siliceous andesites, persiliceous andesites, trachytes, and rhyolites. Hypersthene andesites are only locally developed, and not as widespread as was formerly supposed."

Hodge, E. T. New Evidence of the Age of the John Day Formation. Bull. Geol. Soc. of Amer. Vol. 43 695 1932.

73

(Content)

"Fossils discovered indicate a lower Miocene age for the John Day formation.

The greatest difference between the John Day formation and the Columbia River Basalt is their lithic composition. Both are of magmatic origin, but the John Day formation is composed of ashes and a few thin flows of rhyolitic material, whereas the Columbia River Basalt is composed of an olivine free basalt (hawaiite). The two formations are chemically dissimilar, and if they belong to one geologic period and to one magmatic expression, it would be exceptional. The writer believes, however, that both could represent exhudations from one magmatic reservoir, the John Day being the persilicic magmatic differentiation blown off as ash during the first stage of vulcanism and the Columbia River Basalt flow the subsilicic differentiation that welled up in much greater volume during the last stage of vulcanism. From this point of view, the John Day formation and the Columbia River basalt would belong to the same geologic period, be it Oligocene or Miocene."

Evidence pointed out to indicate the Cascade Mountains as a source of much of the John Day formation material.

Hodge, E. T. History of the Columbia River Gorge. Bull. Geol. Soc. of Amer. Vol. 43 P. 131 1932

74 (Abstract)

"The gorge of Columbia River through the Cascade Mountains affords the finest cross-section of the latter found in Oregon. The oldest formation exposed is the Eagle Creek or Warrendale of Oligocene age. Lying structurally unconformably upon this formation is the Miocene Columbia River basalt, usually divided into two parts by an erosional unconformity.

The eroded surface of the Miocene basalt was buried beneath late Pliocene or early Pleistocene pyroclastics. Pleistocene flows from nearby volcanoes, in successive epochs, erupted along a general north-south line. These lavas produced the Cascade Mountains and dammed the old course of the Columbia River and caused it to be diverted consequently into a trough formed by these lavas along its present route. The diverted Columbia eroded the pyroclastics and the early andesite and mingled its erosional products with quartzites brought from its upper course, and deposited the Troutdale formation in the form of a broad piedmont fan on the west side of the Cascade mountains.

Columbia River, following its consequent course, was entrenched in its present canyon and superposed upon the Miocene basalts and the Oligocene Warrendale. The buried pre-canyon north-south valleys were exhumed producing abrupt widenings. The time of diversion appears to have been after the period of glacial-erratic distribution. The Canyon was superposed also upon an elongated boss, one of the feeders of the early Pleistocene lavas, which cut the Columbia river basalt, thus definitely proving that the valley is not antecedent.

The latest lava flows of the Cascade Mountains involve three periods of eruption, with erosion periods between.

Late Pleistocene lavas built the first Mount Hood and the lavas of its later crater are intercalated with glacial moraine. Recent vulcanism has again begun to dam old valleys and rearrange drainage.

The new evidence makes the size and depth of the canyon more remarkable since it has cut over 2000 feet in andesite and dense basalt since early Pleistocene times.

Hodge, E. T. Oregon Batholiths. Northwest Science 7:2:34 1933.

75 (Content)

"Oregon is one of the most remarkable igneous terranes in the world because of the duration, persistance and intensity of its magmatic activity. Geologic mapping of Oregon shows that 85% of all known rocks and 75% of all Tertiary rocks by volume are of igneous origin. Igneous activity took place on a large or small scale in the pre-Cambrian, Siluro-Devonian, Mississippian, Permian, Triassic, Jurassic, Cretaceous, and in each of the tertiary periods. No Cambrian or Ordovician formations are known in Oregon.

One or more erupting or intruding magmas were continuously active throughout geologic time except as follows: probably in Cambro-Ordovician periods, perhaps during mid-Carboniferous time, again in mid-Jurassic time, until the close of the Cretaceous, between the Eocene and upper Oligocene and during the middle and lower Pliocene....... The Tertiary in Eocene, upper Miocene, and late Pliocene and Pleistocene have been more active than all other epochs, except the last of the Jurassic. Few other regions of Tertiary formations contain such a large volume of igneous rock and indicate such a dominance of igneous activity over all other forms of geologic activity.........

The "Coriba formation" resulted from the largest single surface expression of volcanic eruptivity in the world and the principal rock unit in the state of Oregon it is composed of approximately 150,000 cubic miles of basalt. This formation, the writer believes, was deformed by sagging over an extravisated area rather than by diastrophic forces of compression or extrusion as usually defined. Investigations indicate that Oregon lies in a non-seismic area and an explanation is suggested that a liquid magma still exists beneath Oregon and that many of the shock producing surfaces are cushioned by igneous rock.......The rocks that occur belong to the wellknown types such as biotite granite, hornblende granite, albite granite, rhyolite, tonalite, alaskite, granodiorite, trachyte quartz, diorite, andesite, monzonite, diabase, hypersthene basalt, hawaiite, dacite, gabbro, perioditite, saxonite, pyroxenite, olivine-basalt, and a great variety of glass.

Dr. Frank F. Grout, chairman of the National Research Council's Committee on Batholith Problems says:

'Data in Oregon suggest a large batholith active in the region continuously from pre-Cambrian to Recent time.' This needs a check and critical review, for while the idea is very stimulating, and, if true, very significant, it upsets a large number of speculations and assumptions in areas like the Canadian Shield. Correlations over wide areas have been based on the idea that in the Shield there have been two and only two, rather restricted periods of batholithic invasion."

Hoffman, M. G. Structural Features in the Columbia River Lavas in Central Washington. Jour. Geol. XLI No. 2 1933

76

(Abstract)

"Structures in the Columbia River lava were studied principally in the Moses Coulee area of central Washington. Here a 1900 ft. section of olivine basalts rests with apparent conformity on upper Miocene sedimentaries. The lavas exhibit many different types of structure such as columns of various sizes, cross jointing, irregular fracturing, fan-like forms, rosettes, horseshoe shapes, ellipsoidal and brecciated basalts. The conditions under which the lavas were extruded, the probable methods of formation of the fans, and ellipsoidal and brecciated basalts are discussed.

Probably Manner of Extrusion.

Very few flows appear to have resulted from one massive extrusion. Those which from a distance appear to be homogeneous layers 150 or more feet thick are found to consist of a series of sheets 10-30 feet thick which have merged in some places, but have retained their identity in others. The merging, pinching out, and replacement of the sheets occur within such short distances it becomes apparent that the lava did not travel far from its source. Lava in very thin layers may have moved but a few hundred yards from the point or line of eruption while in the thicker layers in most instances, it probably did not flow more than a few miles. There is nothing to indicate that the same passages were used by successive eruptions. Where dikes were seen they could not be traced to more than one flow. Although some of the old fractures may have been reopened, many new fissures were undoubtedly made immediately preceding each extrusion.

The basic magma was probably intruded close to the surface and initiated a condition in which the overlying crust floated on the liquid substratum. Tension fractures were produced by the uneven sinking of this crustal layer. The liquid was forced to the surface largely by the pressure of the overlying rock, and to some degree by the force back of the intrusion. Each outpouring occurred simultaneously with the sinking of the land surface. The latter changed occurred periodically on account of the tendency of the solid not to break until after its elastic limit has been reached. In this manner further settling and fracturing took place after the extrusion and solidification of each flow. The process continued until all, or nearly all, of the lava had been forced to the surface, the final surface level probably being not much changed from what it was at the start.

Petrography

An average mode is as follows: labradorite 52%, augite 39%, oliving 4%, magnetite 3%, cryptocrystalline material and glass 2%. All the minerals are quite fresh and unaltered. The labradorite occurs in needles and laths. Many of the augite crystals have a small 2 V-angle approximately 30^{o}, and may probably be pigeonite. Most of the olivine is present in small irregular grains. The outlines of the medium-sized olivine crystals show distinct resorption effects. The magnetite is present in small crystals, grains and dendritic forms in the intercrystal spaces, and appears to have been the last mineral to crystallize. No accessory minerals were noted."

Jamieson, G. S. On the Natural Iron-Nickel Alloy Awarite. American Journal of Science (4) 1905

77 (Content)

"The specimens from Josephine County were waterworn bean-shaped pebbles, varying in size from a few milimeters to two centimeters in diameter and were composed not only of the alloy, but also of more or less siliceous matter.

Analysis:

Insoluble silicate	24.15
Iron	19.17
Nickel	56.30
Cobalt	.35
Phosphorous	.04
Sulphur	.09
	100.10

Iddings, J. P. Igneous Rocks. John Wiley & Son, New York 1913 Vol. II 435-37

78 (Content)

"The Klamath Mountains in northwestern California and southwestern Oregon are similar to the Sierra Nevada ranges in geological structure, but consist chiefly of sedimentary formations intruded by many dikes and masses of granodiorite, gabbro and serpentinized peridotites. They also contain metamorphosed volcanic rocks of Paleozoic and Mesozoic Age. There are massive bodies and tuffs of altered andesites and rhyolites of Devonian or Pre-Devonian Age, and flows and tuffs of diabase and a small amount of dacite or quartz-latite that are Carboniferous. There are Triassic flows and tuffs of andesite and rhyolite, and Jurassic andesites. In the late Jurassic or early Cretaceous times were intruded batholiths, stocks and dikes of quartz diorites, and dikes of andesite-and dacite-porphyries, also a stock of peridotite. In Tertiary times basalts were erupted......

In Oregon in the vicinity of Port Orford there are igneous rocks probably intruded in Cretaceous times. They are serpentinized peridotites and gabbros of various kinds, hessose, auvergnose, beerbachose, and a persodic variety of piedmontase and dikes and other masses of dacite-porphyry, kallerudose, yellowstone, and alsbachose-lassenose.

The Cascade Range extending from Lassen Peak and Mt. Shasta at the south of Mt. Rainier in Washington, is built up almost wholly of volcanic rocks in tuffs, breccias and lava flows with dikes and other forms of intrusions not much exposed. Beyond Mt. Rainier the northern Cascade Range is mostly stratified rocks to its termination near the 49th parallel of latitude. The earliest eruptions in the Cascade Range were in Eocene times and the latest probably in the Quarternary, or within the Present era. The bulk of the rocks is andesite, chiefly pyroxene andesite with less hornblende-pyroxene andesite, and quite subordinate amounts of hornblende and mica-andesites.

At Crater Lake, Oregon, volcanic eruptions began in the Eocene and the greatest activity was reached in Miocene time. The bulk of the lavas and tuffs is andesitic, chiefly pyroxene andesite, tonalose. Smaller portions are dacites, lassenose, and still smaller basalts, andose and beerbachose.

The 76 igneous rocks of the Cascade Mountains that have been analyzed belong in 24 magmatic divisions of the quantitative system, 56 falling in 5 divisions:

tonalose 22	hessose 8
lassenose 11	yellowstonose 6
andose 9	

All of these are dosodic. Only 9 of the 76 rocks analyzed are solipotassic.

The Blue Mountains: in northeastern Oregon lie to the east of the Cascade Mountains and consist largely of sedimentary strata with intrusions of igneous rocks and areas of extruded lavas. The history of volcanic action is similar to that of the northern Cascade Mountains. The common intrusive rock is granodiorite with diorite and gabbro facies. A typical variety occurs at Bald Mountain, northeast of Sumpter and is yellowstonose. There is no orthoclase granite in this region but a highly sodic albite-granite. In Tertiary times there were eruptions of andesite and rhyolite in the Eocene and some of rhyolite in the Miocene. But the great eruptions in Miocene time were basaltic, and lava flows accumulating to a thickness of over 1000 feet and extending eastward into Idaho. With the basalts are intercalated some flows of rhyolite and fewer of andesite. East of Cornucopia the basalt flows are 2000 feet thick; and in numerous localities, especially in the Bonanza Basin near Cornucopia there are many dikes of basalt which appear to have been the source of the surficial flows. The basaltic lavas from the Columbia River lavas, covering large areas in central Washington, eastern Oregon and western Idaho.

In the John Day Basin: the sequence of eruption was as follows: In the John Day Miocene, trachytic tuff, andesitic tuff, followed by more than 2000 feet of basalt; in Mascall Miocene rhyolite, basalt and possibly more rhyolitic tuff; in the Pliocene, rhyolite.

The basalts of the Columbia River belong to various formations, some being Pliocene, overlying the Columbia lavas properly so called. Such are the recent basalts of the Modoc plains in northeastern California and the recent basalts of northeastern Idaho which cover the upper Snake River plains and extend over the rhylites from the Yellowstone National Park. These basalts of the upper Snake River, which might be called the Shoshone basalts, extend from the eastern boundary of Idaho as far west as the neighborhood of Boise, where they overlie the Columbia River basalts."

Kay, G. F. Nickel Deposits of Nickel Mountain, Oregon
U.S.G.S. Bull. 315 120 1907

79 (Content)

"The nickel deposits are associated with saxonite or harzburgite, a variety of peridotite, a basic igneous rock consisting chiefly of olivine and enstatite. Olivine constitutes more than two-thirds of the whole rock. Chromite and magnetite are in general present as disseminated grains, Though within the peridotite area there are segregations of almost pure chromite......

Other igneous rocks in this region are less basic than the peridotite and may be designated as greenstones and dacite porphyries. The greenstones comprise several types of rock, all of which are more or less dull green in color. They vary in texture from fine-grained and compact to coarsely granular. Most of them are considerably altered, but when fresh are usually found to consist essentially of pyroxene and soda-lime feldspars. The dacite porphyries are rather fine grained light colored rocks and are far less abundant than the serpentines and greenstones. The chief minerals present are quartz and soda-lime feldspars both of which in many places form distinct phenocrysts.

The peridotite appears to have cut up through the greenstones but was itself intruded by dacite porphyries."

Includes a chemical analysis of the ore and the geologic range of the ore bodies, development and history of the deposits.

As to the genesis of the ore:

"Evidence points to the breaking down of the peridotites under favored conditions of weathering brought about by excessive fissuring."

The weathering process is discussed.

Kellogg, A. E. Platinum in the Quartz Veins of Southwest Oregon. Engineering and Mining Journal Press 113 1000. 1922.

80

(Content)

"Platinum, like chrome, in southwest Oregon is closely associated with serpentine. The native alloy of platinum, iridium and osmium, in which platinum is found in nearly all the gravel deposits of this region is apparently derived from the serpentine. That is these metals are believed to be the primary constituents of the igneous rock, which have altered to serpentine."

Mentions occurrence of Tonalite intrusions in Applegate district.

"Platinum reported from Blue quartz veins of the Highland Mines, Gold Hill district but it seems occurrence was not definitely proven."

Keyes, Charles Oldest Unmetamorphosed Rocks are Around the Pacific Basin. Pan-American Geologist 44 207-224 1925

81

(Content)

Would date flows in basal Columbia River gorge from the Paleozoic. Depth of cut used as evidence. A semi-popular account rather than scientific.

Le Conte J. The Great Lava Flood. Amer. Jour. Science (3) 7:167 1874

82

(Content)

On area, source, thickness, structure, age of Cascade Mountains, theory of the ejection of the lava flood, and formation of mountains.

Describes the "great lava flood" as a universal flood overlying the original face of the country several thousand feet thick and covering approximately 300,000 square miles...

Ledoux, A. R. Notes on the Oregon Nickel Prospects. Canadian Min. Rev. Vol 20 84-85 1901

83

(Content)

The geologic relations of the ore are discussed. A chemical analysis of the ore is given.

Lupher, R. L. Geological Section of the Ochoco Range and Silvies Plateau South of Canyon City, Oregon. Bull. Geol. Soc. of Amer. Vol. 42 1931

84

(Abbreviated Abstract)

"It is of interest to note that several formations and at least four angular unconformities intervene between close correlative of the Columbia

River lava and Mascall formation.

Much of the present plateau surface was formed by a puniceous, acid flow, correlated with the Rattlesnake Pliocene, which spread widely over an exceedingly flat erosion surface south of the Ochoco range. The enclosed basins known as Bear and Silvies valleys are structural downwarps in this plateau surface.

The Mesozoic sediments are highly folded and often overturned, but they are not appreciably metamorphosed. The structure of the Tertiary sequence is relatively simple. However, igneous intrusion and erosion of a series of thin formations showing excessive overlap have greatly complicated the areal pattern. Faulting is inconspicuous except on upper Canyon Creek where some late Tertiary rocks have been dropped into a deep pocket south of Canyon Mountain."

Lindgren, Waldemar: Gold Belt of the Blue Mountains of Oregon. U.S.G.S. Annual Report 22 Pt. 2 551-776 1901

85 (Content)

A complete treatise on the Blue Mountains mining region including the geologic history, mineral deposits, mines and development and geologic map:

Igneous rocks described are as follows: (rock descriptions abstracted only)

"Paleozoic Lavas: altered greenstones and tuffs, schistose.

Triassic Lavas: old basalts andesites and tuffs. greatly altered but not schistose.

Intrusive Rocks:

Granite: True orthoclase granite appears to be absent from this area. The granitic area of Sparta consists of a normal soda granite in which orthoclase is almost entirely wanting, its place being filled by albite. (Chemical analysis given).

Granodiorite: A normal granodiorite of an acid type, containing a little more quartz than the granodiorite of the Sierra Nev. Chemical analysis.

Diorite: Occurs as a facies or local development of granodiorite, is a dark-grey to dark-green granular rock consisting of andesine or labradorite feldspar, greenish hornblende and sometimes brown biotite, with magnetite and titanite as accessories.

Gabbro: Greenish grey granular rocks associated with the dioritic rocks, composed chiefly of a basic plagioclase and a pyroxene often converted into uraltic hornblende crushed but not schistose.

Diabase: The diabases are granular rocks belonging to the gabbro family and consisting of augite and labradorite feldspar, intergrown with peculiar and characteristic structure.

Serpentine: Ordinarily dull-green in appearance and has not suffered greatly from pressure. Thin sections from Canyon show a normal rock with grate structure, containing abundant magnetite forming a network in the clear serpentine mass. Chromite is found in the serpentine south of Prairie and near the Winterville placer mines.

Dike Rocks

Diorite Porphyries

Aplites: found near the contacts of intrusives as are minor dikes of diorite and granodiorite.

Porphyry dikes: of light color, completely altered, bleached, and softened, occur in the Red Boy mine.

Pegmatitic dikes: Are contained in the diorite of the Coyote Hills, containing orthoclase, microcline, and quartz together with some idiomorphic andesine and small grains of augite--a very unusual character of pegmatite.

Dioritic dikes: Of the Kersantite type of lamprophyres. In Idaho it has often been observed that gold quartz veins follow such narrow lamprophyric dikes.

Neocene Lavas: The Neocene period in the Blue Mountain region, as throughout the whole of Oregon, Washington, and California was characterized by enormous eruptions of lavas of different kinds. So far as is known the Neocene lavas of the Blue Mountains belong, almost without exception, to the earlier part of the Neocene period--that is, to the Miocene. Late Neocene (Pliocene) and even Pleistocene eruptions are known to have taken place in different parts of the northwestern states, but in this region it seems as if the Pliocene epoch had been one of quiescence as far as eruptions were concerned. The Neocene lavas surround the Blue Mountains almost completely. They fill the old valleys of a drainage system occupying a lower level than that of the present streams. The highest parts of the Blue Mountains are, as a rule, not covered with these flows, but on sheets, aggregating as much as 2000 feet in thickness.

The rocks of this series are separated into three groups--the basalts, the rhyolites--and the andesites. The basalts are the most widely distributed of the rocks, but the rhyolites and the andesites also occupy large areas.

Rhyolite: a normal reddish or brownish lithoidal variety, with small crystals of quartz and feldspar contained in a streaky microcrystallin to crypto-crystallin groundmass.

Dacite: contains abundant prophyritic crystals of quartz, glassy feldspar, and brown biotite in a hyprocrystallin groundmass of trachytic structure. The feldspars are a plagioclase approximating to labradorite in composition and the rock should therefore be classed as a dacite.

Andesite: The rock is light grey and porphyritic, containing small phenocrysts of feldspar and hornblende in a fine-grained groundmass consisting of plagioclase and hornblende. The structure of the groundmass is trachytic. The feldspar phenocrysts are apparently labradorite.

Basalt: In petrographic character the basalts show little variation. They are entirely normal rocks of their kind, with or without olivine

> and ordinarily contain a moderate amount of glassy groundmass. Occasionally, however, this glassy base almost disappears, and the rock then is usually somewhat coarser, having the appearance of a diabasic rock. Vesicular and massive flows alternate, the former are usually the more glassy varieties. Constituents, lath-shaped crystals of labradorite, abundant fresh, small olivine grains and a brownish augite. These constituents are cemented by a small amount of dark brown glass sometimes containing very beautiful arborescent forms of magnetite. Some have pyroxene and hypersthene phenocrysts.

The question of the manner of eruption of these enormous masses of basalt has always been an interesting one. It is generally believed that the magma was not ejected from volcanoes, but that it poured out in a comparatively quiet manner from large fissures in the crust. This view has been substantiated by the discovery of a large number of basalt dikes at Cornucopia and other places high upon the flanks of the mountain, and in such a position relative to the flows that it is not to be doubted that the foci of the eruption were located at these places."

Lindgren, Waldemar: Geological Features of the Gold Production of North America. A.I.M.E. Transactions 33 833 1903

86

(Content)

"The gold deposits of Oregon are contained partly in the southwestern and partly in the northeastern corner of the state. The former are the direct continuation of the California gold-belt. The mines of northeastern Oregon are similar in character with the California belt and both districts are evidently the same age--that is they belong to the Cretaceous period......The veins are clearly connected with the intrusion of late Mesozoic granitic rocks into older Paleozoic and Mesozoic sediments and were formed shortly after this intrusion.

Post Miocene deposits have been found in at least one place, the Bohemia mining district in the Cascade Mountains where according to Mr. J. S. Diller,

veins of gold and silver occur in andesite.
By far the largest part of the output--in fact, practically the whole--is to be credited with the Cretaceous gold-quartz veins."

Lindgren, Waldemar Nampa Folio, Idaho-Oregon. U. S. G. S. Geological Atlas Folio 103 1904

87 (Content)

Rhyolite and dacite the only igneous rocks mapped in Oregon.

"The former is of a felsitic type, consisting chiefly of a very fine grained microcrystalline to cryptocrystalline mass of alkali feldspar and quartz in which a few small scattered phenocrysts of the same minerals are embedded. The groundmass is often characteristically streaky by irregular alteration of coarser and finer aggregates. Biotite is of rare occurrence, the rock is generally vesicular, in places also tuffaceous, the cavities are often filled by opal and other forms of silica.

Associated dacite: On the northeast side of the rhyolite area appears a dike of somewhat different and apparently less acid rock. It is very similar to certain dikes in the silver City quadrangle which have been determined as dacite or acidic andesite. This rock is light grey or brownish and contains small phenocrysts of orthoclase, andesene, biotite, and hornblende in a very fine grained micro-crystalline groundmass."

Lindgren, Waldemar Mining Districts of Western United States. U.S.G.S. Bull. 507 1912

88 (Content)

"With the exception of the small mineralized areas of Baker, Grant, Douglass, Josephine, Jackson, and Coos counties, the whole state is covered or underlain by flows of late Tertiary lavas, mainly andesites and basalts, or as along the western coast by Tertiary or Cretaceous sediments."

Mallery, W. Native Gold in Igneous Rocks. Engineering & Mining Journal. 77 596 1904

89 (Content)

Concludes that a large part of the placer gold of the Grants Pass region has been derived as an original constituent of the basic igneous rocks, diabases and diorites, but has only indirect evidence to support this conclusion.

Marlatte, Cr. R. The Petrogenesis of the Clastic Materials of the Madras Formation. Univ. of Ore. Thesis 1931

90

(Content)

The Madras formation, lavas, tuffs and sediments, is discussed and its extent is outlined on a base map.

(Igneous rocks)

No petrography on strictly igneous rocks was done.

Merriam, J. C. Contribution to the Geology of the John Day Region. Cal. Univ., Dept. Geol., Bull. 2 No. 9:269-314 1901

91

(Content)

(Igneous Rocks)

Notes occurrence of dikes, including the Davis dike, penetrating the John Day beds in the vicinity of Turtle Cove thus giving the first evidence of the prevailing mode of extravasion of the lavas.

Parks, H. M. Report on Building Stone in Oregon. O.B.M.&G.
Vol. 2 1917

92 (Content)

Notes occurrence of diabase 6 miles north of Willamina.

"This rock is considerably altered medium grained diabase--dull greyish green color in polished section and has a somewhat mottled appearance due to the peculiar arrangement of constituent minerals.

Minerals:

Pyroxene......48%
Plagioclase...40%
Magnetite.....12%

The plagioclase and the pyroxene are considerably altered giving rise to the green color."

Redway, J. W. Great Lava Flood. Amer. Bureau Geol. Bull.
2:157-63 1901

93 (Content)

A more or less popular account of the great lava flood. Notes that the flows blocking and obliterating the Columbia and Snake rivers originated from fissures. Notes a large number of craters on the Deschutes plain and states that crater eruptions are sometimes the offspring of fissure eruptions, no matter whether the latter are intrusive or extrusive. According to Fisk[1] these craters are probably the origin of subsequent Pliocene or Pleistocene lavas which overlie the Columbia River basalt in the Deschutes plain.

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1. Fisk, H. N. The History and Petrography of the Basalts of Oregon. U. of O. Thesis. 1931.

Renick, B. C. Petrology and Geology of a Portion of Malheur County, Oregon Jour. of Geol. 38 481 1930

94

An extensive treatment of the petrography of this region.

(Abstract)

"Along the Owyhee River in southeastern Malheur County the rocks are of late Tertiary and Quarternary age, consisting of conglomerate, arkosic sand, and sandy shale, all derived largely from volcanic material and interbedded with volcanic tuff, basalt, and rhyolite. The stratigraphy and petrology of the igneous and sedimentary rocks are described in some detail. The structure simulates a northward-plunging anticlinal nose that has been considerably faulted, mostly parallel to the trend of the nose.

Locally the basalt flows and the sedimentary beds immediately below the flows are colored red, Also, some of the basalts contain zeolites. The cause of the red color and the origin of the zeolites are discussed, and the hypothesis is advanced that some of the flows were erupted into standing water.

Igneous Rocks:

"Glassy Mountain Basalt": Normal olivine basalt, overlying and in part interbedded with the upper beds of the Payette formation, Miocene and Pliocene.

Blackjack basalt: A now olivine-bearing normal augite hypersthene-labradorite, interbedded with beds in middle of the Payette formation east of Owyhee River, Miocene.

Owyhee basalt: Augite hypersthene basalt; grades from black to red and from dense to scoriaceous and cindery phases; contains a few beds of water laid tuff; overlies the tuffaceous conglomerate, Miocene.

Porphyritic Rhyolite: Plagioclase-augite porphyritic glass including felsite, felsite breccia, pitchstone, and pitchstone agglomerate; overlies the tuffaceous conglomerate.

Partial Analysis. By J. G. Fairchild.

		Calculated Norm	%
SiO_2....	71.71	Quartz......	28.80
Al_2O_3...	14.49	Orthoclase..	23.91
Fe_2O_3...	2.01	Albite......	32.49
FeO.....	0.30	Anorthite...	10.29
MgO.....	0.25	Diopside....	1.08
CaO.....	2.35	Hypersthene.	0.10
Na_2O....	3.84	Magnetite...	0.23
K_2O.....	4.06	Hematite....	1.92
TiO_2....	90.25	Ilmenite....	0.46
	99.26		99.28

Basalt dikes intrude the rocks below the Owyhee basalt and represent feeders to the basalt sheet."

(Abstract, B.G.S.A. 31:151 1926)

"......The rocks consist of volcanic flows and dikes and sediments derived largely from rocks of volcanic origin. The oldest rocks are sediments consisting of conglomerate, arkosic sand, sandy shale and tuff. These lie stratigraphically below what is believed to be the equivalent of the Columbia River basalt. Above these sediments in a portion of the region, and also below the Columbia River basalt, is a glassy rhyolite porphyry with quartz sparingly present. The Columbia River basalt is a normal basalt and the essential constituents are labradorite, hypersthene, and augite. Some beds of tuff are interbedded with the basalt.

Above the Columbia River basalt there are interbedded sediments and basalt flows. Both olivine and normal basalt are represented by these post-Columbia River flows, several of which show lithological characteristics by which the local structural features may be worked out with considerable accuracy. The post-Columbia olivine basalt and some flows of the Columbia River basalt contain zeolites, and the data are presented which suggest that they were erupted into water. The Payette formation and possibly the Idaho formation are represented by these sandy shale, ash, tuff, and fine conglomerate."

Rickard, T. A. Veins of the Union and Companion Mines, Cornucopia Union Co., Oregon. A.I.M.E.
95 Trans. 26:193, 1896

(Content)

"The country, a fine grained granite, is not visibly altered under the foot-wall but along the hanging it exhibits an alteration of its more soluble ingredients."

Discusses further the ore deposits relations of the veins.

Rossiter, Raymond. Charcoal. A.I.M.E. Transactions
11:119, 1883

96 (Content)

Described occurrence of charcoal formed by the carbonization of the leaves and twigs of plants in the layers of mud between successive overflows of lava.

Russell, I.C. Geological Reconnaissance in Southern Oregon1
U.S.G.S. Annual Report 4:431 1884

97 (Content)

Southeastern Oregon, Harney and Malheur Counties.

> "The events in the later geological history of the portion of the great Basin embraced within our reconnaissance may be briefly summarized as follows:
> The rocks are almost entirely igneous; and occur on the southern border of an immense volcanic region that stretches indefinetely northward."

Russell, I.C. Principal Features of the Geology of Southeastern Washington. Amer. Jour. of Science (4) 3:246. 1897

98

(Content)

The general extent, topographic and physiographic features of the Columbia River lava sheet are described. No petrography attempted.

Russell, I. C. Geology of Nez Pierce County, Idaho.
U.S.G.S. Water Supply Paper No.53 1901.

99

(Content)

The Snake River lavas of southwestern Idaho are Correlated with the Columbia River lavas of northeastern Oregon.

Russell, I. C. Recent Volcanic Craters in Idaho and Oregon.
Bull. Geol. Soc. of Amer. 14:549 1904

100

(Abstract)

Four groups of craters were described, namely the Cinder Buttes, Idaho, and the Diamond, Jordan and Bowden craters, Oregon.

> "The craters in each of these groups are remarkably fresh and furnish typical examples of both cinder cones and lava cones. Vast volumes of lava were poured out from each of the groups of craters, which at the time of its extrusion was highly liquid, but became exceedingly viscous as it slowly cooled. Illustrations were shown of cinder cones, driblet cones, "or ovens" lava "gutters", a large variety of volcanic bombs, dunes of lapilli, large fragments of tuff derived from cinder cones ruptured by escaping lava and floated on the lava streams, islands in the lava streams, characteristic features of the surfaces of lava streams, etc."

Sheets, M. M. Contributions to the Geology of the Cascade Moutains in the Vicinity of Mount Hood.
University of Oregon Thesis 1932

101

Petrographic Relations:

> "In the Mount Hood area, the most noticeable feature of the whole petrographic problem is the dominance of andesitic rocks. They are found as pebbled and flows through the entire length of the column except in that central portion occupied by the Coriba formation. In the strict sense, however, even the Coriba is very closely related to the andesites because it is composed entirely of andesine basalts....."

Contains petrographic descriptions with photomicrographs of certain rock types.

Smith, W. D. and Packard, E. L. Salient Features of the Geology of Oregon. Univ. of Ore. Bull. Vol,16, No. 7, 1901

1o2

(Content)

A brief but accurate review of the literature and ideas of Oregon geology prior to 1919.

(Igneous rocks)

"Igneous rocks are found conspicuously developed in three regions in Oregon: (a) the Blue Mountains, (b) the Cascades, and (c) the Klamath Mountains. In the Blue Mountains the dominant type is granodiorite, in the Cascades basalt and andesite, and in the Klamath serpentinized peridotite, gabbro, and granodiorite.....

The dominant rock in the Cascade region is the Columbia lava, which is basaltic. The principal rock in the Cascade superstructure is andesite. In the metaliferous districts of the southwest and northeast granodiorite is the chief rock.....

The serpentinized peridotites in the vicinity of Port Orford are both interesting and valuable economically because of the association of chromite and nickel. According to Diller they were probably intruded in Cretaceous times.

It will be seen from the testimony of the literature that the dominant igneous activity in the state has occurred later in geologic time, in the Mesozoic and Cenozoic. Very little is definitely known of the igneous rocks of the Paleozoic, and little or nothing of the pre-Cambrian, if indeed there were any at all at that time in this state.....

Steinmann (2) asserts that the average igneous rock of the South American Cordillera is similar to that of the Pacific Coast of North America. He says that the lavas of the former region are andesites, dacites, and rhyolites, and that granodiorites are the prevailing intrusives. In this connection Becker and W. D. Smith have repeatedly called attention to the relation between the igneous rocks of the Philippines and of Oregon. If we pass a great circle along the axis of the Cascades, we shall find that it will pass remarkably close to the Cordilleras of Japan and the Philippines, and it is only to be expected that we should find this petrographic similarity along such a great and persistant tectonic line.

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(2) G. Steinmann, Geol. Rundschau I (1910), 13.

Definite figures as to the size of intrusive batholiths in Oregon are at present unavailable. In the Blue Mountains the granodiorite is very prominent and attains elevations close to 10,000 feet and covers hundreds of square miles, while in the Cascade region it is seen in one or two localities only, and these low down and in very limited exposures. In the Siskiyou region (southwest) also there are large masses of granodiorite."

Smith, W. D. Summary of the Salient Features of the Geology of the Oregon Cascades. Am. Jour. of Science (4) 46-546 1918

103

(Content)

"We know little with certainty about the events and formations prior to the Tertiary and that the west coast geological events are similar to those on the other side of the pacific. The three most striking instances of this similarity are the period of Tertiary gold deposition, practically contemporaneous around the entire pacific arc, the Eocene coal formations, and the tremendous eruptions of basaltic and andesitic lavas, which continue to this day, though not on so extensive a scale as in the past.

The general conclusion is that the geology of the various countries bordering on the Pacific must be deciphered and interpreted by duly considering the data from all these regions."

Smith. W. D. Contribution to the Geology of Southeastern Oregon--Pueblo and Steen's Mountains. Jour. Geol. V. 35 1927

104 (Content)

On the method of extrusion of the lavas says:

"In view of such vents (local around Steen's Mountain) and the dikes seen in the eastern face of Steen's Mountain, we can be quite positive in our conclusion as to the formation of the great eastern Oregon lava flood. In the first place, what is known as the Snake River or Columbia lavas is a composite of many floods; and second it came from many vents, some more or less local and circular, while others were lineal fissures."

Smith, W. D. Physical and Economic Geography of Oregon Chap. XIII, The Wallowa Mts. & County. The Commonwealth Review, Jan. 1928

105

(Content)

Contains a generalized cross-section of the Wallowa Mts. showing them to be composed of granodiorite, greenstone, metamorphics and questional Columbia River lavas.

Stearns, H. T. Geology and Water Resources of the Upper McKenzie. U.S.G.S. Water Supply Paper 607b; 171-189, 1929.

106

(Content)

States "that the entire area around the upper McKenzie River is occupied by basaltic lava flows that issued from numerous vents on the summit of the Cascade Range from the late Tertiary to geologically recent time. Many of these flows are so new as to be nearly bare of vegetation."

Sylvester, A. H. Evidences of Recent Volcanic Activity and the Glaciers of Mt. Hood, Oregon. Science: 27:585 April 1908.

107

(Content)

Evidence of increased thermal heat, August 1907, of Mt. Hood brought out as an indication of a possible returning cycle of volcanic activity.

Tuck. R. The Geology and Ore Deposits of the Blue River Mining District. Univ. of Ore. Thesis, 1927

108

(Content)

Discusses geology of region, mining, paragenesis and mineralogy of the ore deposits.

The following igneous rocks are petrographically described and appear with photomicrographs:

SM 116 Quartz Monzonite

BR 8 Andesite

SM 115 Basalt

BR 7 Andesite

Washburn, C. Geology and Oil Prospects of Northwestern Oregon. U.S.G.S. Bull. 590, 1914.

109 (Content)

"The coast range of northwestern Oregon is a broad, low geanticline of Tertiary formations broken by many igneous intrusions........ The Eocene igneous rocks of the Coast Range are distinguished from the post-Eocene lavas by the greater amount of feldspar, the absence of olivine and the presence of more or less hornblende."

Waters, A. C. Structural and Petrographic Study of the Glass Buttes, Lake County, Oregon. Jour. Geol. 35:441-52 1927

110 (Abstract)

"The Glass Buttes, a small mountain range composed entirely of volcanic rocks, have as their dominant structural features, an anticline. This anticline has been very greatly modified by a multitude of normal faults. The lavas of the district represent three periods of extrusion. The older flows of basalt were followed by a series of acidic lavas which were, in turn, partially covered by a later series of basalts."

The petrography of these three periods of extrusion is discussed at some length.

"Change in composition of flows: The difference in composition shown by the petrographic analysis of these two flows points to rapid changes in composition of the original magma, from which the flows were fed, in a very short space of time. Although they are in part separated by a soil layer, this soil is of a transported variety and the original surfaces of the flows shows scarcely any alteration from weathering. In the older flow counts made of the proportions of different minerals by comparing areas occupied in thin section show the rock to contain about 65% olivine and augite. In the younger rock the amount of augite present is only about 30%, and olivine is entirely absent. Although considerable amounts of glass are present, it is improbable that the difference in the quantity of the mafics shown in the crystallin portions of the rock is compensated for in the composition of the glass. The labradorite in the younger flow is also of a less calcic variety than that in the older. Changes in viscosity attend the change in composition; although the older flow is the same thickness as the younger, it must have been markedly more fluid. It is of holocrystalline and of ophitic texture, while the younger flow has an intersertal groundmass characterized by large amounts of glass and marked fluxional structure. The crystallinitey of the lower flow cannot be explained by assuming that these flows were nearly contemporaneous, and that the upper flow acted as a thermal blanket for the lower, because a thin soil layer is seen to separate them.

Relation of the volcanic rocks at the Glass Buttes to the Southern Oregon Volcanic Field.

Lavas of basic and acidic composition are widespread throughout southern Oregon. The acidic and basaltic flows appear to be everywhere conformable, and at several localities are interbedded. Basaltic flows of very recent origin are also widespread. The older basalts and acidic lavas have been referred to the Miocene, while the younger basalts are known to be very recent. In the Glass Buttes region the older basalts and the dacites and andesites probably correspond in age to the basaltic and acidic rocks exposed on Steen's Mountain and at other localities in south-central Oregon."

Waters, A. C. Concerning the Differentiation of a Lamprophyric Magma at Corbaly Canyon, Washington. (Chelan Quadrangle). Jour. Geol. 35:158 1927

111

(Abstract)

"Evidence is presented to prove that the dike rocks of Corbaly Canyon represent a series of intrusions injected at intervals during the differentiation of an original lamprophyric magma. A very complete series of differentiates, with a quartz hornblende kersantite and a sphenrelitic granophyre as the poles, has been found. That differentiation did not proceed by a splitting of a magma of intermediate or of granitic composition into acidic and basic poles to from "complimentary dikes" is proved by the fact that the basic dikes were intruded earlier than dikes of intermediate and granitic composition.

It is though possible that the original lamprophyric magma from which the differentiates were formed may represent one of the lamprophyric offshoots of the Mount Stuart Batholith which lies about 20 miles to the southwest."

Williams, H. Newberry Volcano of Central Oregon. Bull. Geol. Soc. Amer. Vo. 46 No. 2 Feb. 1935, pp. 253-304.

112

(Content)

Petrography, general statement:

"This paper, instead of taking the lavas in the order of their eruption, will discuss the rhyolites, the andesites, and the basalts, separately. The fragments of plutonic rock will then be described, and in conclusion a summary will be made of the magmatic history and the chemical characters of the volcano as a whole. It must be urged again, even at the cost of repetition, that from the petrotogist's point of view, the leading feature of the Newberry volcano is the intimate relation, in both time and place, of rhyolites and basalts and the unusual paucity of intermediate magmas, a feature in marked contrast with the great outpourings of andesite in the adjacent volcanoes of the High Cascades."

Resume of the History of the Volcano

The main episodes in the history of the Newberry volcano are as follows: First, the upbuilding of a main shield, chiefly by rhyolitic and basaltic eruptions from a central caldera; then, the enlargement of the caldera, principally by down-faulting; and, finally, parasitic eruptions of rhyolite, and basalt both on the flanks of the shield and on the floor of the calera.

Summary of the Magmatic History:

"The following notes are a resume of the petrographic characters and sequence of ejecta of the Newberry volcano. After the main shield had been built to a height of about 2,000 feet above the platform of the "Columbia Lavas" by the outpouring of pyroxene basalts, the earliest of the visible flows were erupted. These are weakly porphyritic and glassy rhyolites carrying a few minute crystals of augite and hypersthene and abundant tridymite. They were succeeded by dense, aphyric flows of augite basalt, extremely poor in olivine and hypersthene. The first violent pyroclastic explosions then took place, erupting both lithic tuffs composed of fragments of the older lavas, and scoriaceous porphyritic basalts rich in large phenocrysts of labradorite, hypersthene, augite, and olivine. Above these follow the only andesites recognized in the volcano. One type of andesite is almost wholly composed of scoriaceous, black glass, in which lie rare phenocrysts of labradorite and still fewer prisms of hypersthene and augite; the other type, also rich in glass, is plentifully charged with large phenocrysts of labradorite, oliving, augite, and accessory hypersthene. Subsequently, flows of porphyritic augite basalt escaped over the north and east rims of the caldera, whereas flows of glassy rhyolite, most of them containing a few phenocrysts of acid plagioclase, augite, and hypersthene, escaped over the south rim and piled up to a thickness of about 1,000 feet. This concluded the formation of the main shield.

The later history of the volcano is concerned with the eruptions on the floor of the caldera and the parasitic outbursts on the flank of the shield. These were more or less simultaneous, but the caldera eruptions will be considered first. They began with flows of glassy rhyolite, and were followed by the protrusion of several domes of rhyolitic obsidian bearing sporadic phenocrysts of acid plagioclase, pyroxene, and accessory basaltic hornblende. About the same time, three large cones of basaltic lithic tuff were formed, in two of which lie lapilli and blocks of gabbro and diorite, and small flows of augite-olivine basalt were erupted. The concluding stages of activity within the caldera were marked by the explosion of cinders of augite basalt, carrying accessory olivine, and by the emission of streams of rhylitic obsidian in which phenocrysts of oligoclase and pyroxene form only an insignificant fraction. Some of these recent obsidians carry rare crystals of hornblende, perhaps derived from the break-up of hornblendic antoliths of dioritic character.

Meanwhile, three domes of pyroxene-bearing rhyolite, heavily charged with tridymite, had risen on the western flank of the shield, and more than 150 cones of augite olivine-basaltic scoria had been built, chiefly on the northern and southern flanks, some of which were associated with outflows of augite-olivine basalt.

Mineralogically, the Newberry series of ejecta is characterized by great paucity of hornblende and mica. In this respect they differ from the lavas of the High Cascade volcanoes and of Steen's Mountain, among which hornblende- and /or biotite-rich dacites and rhyolites are common. Except among the latest basalts contrast with the older basalts of Steen's Mountain and with many of the high Cascade flows. Hypersthene, so splentiful among the andesites and the basalts of the high Cascade volcanoes, is here in only minor amounts and is restricted to the earlies basalts.

In the British Tertiary province, Kennedy[23] points out that olivine rich under-saturated plateau magma is "restricted to those areas where fissure eruptions were succeeded by the establishment of definite igneous (mainly plutonic)centers. He suggests that olivine rich basaltic magma and the centralization of igneous activity may be intimately connected. In that connection, it is to be noted that the plateau basalts of Oregon are, in general, augite basalts, weakly oversaturated. The same is true of the earlier basalts of the Newberry volcano; flows rich in olivine are restricted to the latest products of eruption, when the activity had become strongly centralized."

Differentiation at the Newberry Volcano.

"Thus, the only progressive differentiation noted at the Newberry volcano is among the basalts,

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23. Kennedy, W. Q. The Parent Magma of the British Tertiary Province. Geol. Surv. Great Britain, Summary of Progress, Pt.2 p. 61-73 (1931)

for as time went on these changed from weakly over-saturated types with considerable amounts of olivine. Otherwise, acid and basic magmas were alternately erupted throughout the history of the volcano. Few volcanoes offer a more vivid illustration of the acid basic association.".......

The above association is compared to that of other volcanic fields.

The chemical relationships are shown by "variation diagrams" in which the percentage of the critical compounds, K_2O, Na_2O, Al_2O_3, MgO, CaO, and Fe_2O_3, abcissa, are plotted against the percentage of SiO_2, ordinate. Comparison curves are shown for the Lassen Peak, Crater Lake, and Mt. Shasta, classed as High Cascade, lavas and for the lavas of Newberry Volcano, Steen's Mountain, Medicine Lake and average Oregonian Plateau Basalt.

"Taken as a whole, the Newberry magmatic series is to be classed as calc-alkaline. According to the scheme suggested by Peacock[25], the alkali-lime index of the series is 58. That is to say, at a point on the variation diagram (Fig. 8) where SiO_2 is 58, the sum of the alkalies equals the amount of lime. If the alkali-lime index exceeds 61, a series is said to be calcic. On this basis, the Steen's Mountain and Medicine Lake series are also calc-alkaline, having exactly the same index as the Newberry series. Contrasted with the lavas of these three volcanic centers, which lie on the "Interior Platform of the Columbia lavas" are those of the High Cascade Volcanoes[26]--Lassen Peak, Mount Shasta, and Crater Lake—all of which must be regarded as calcic, having indices of 63.9, 63.7, and 61.5 respectively. Finally, the Miocene igneous rocks of the western Cascades, upon which the high Cascade cones are built, have an index of 61, and are, thus, intermediate between the calcic and the calc-alkaline series."

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25. Peacock, M. A. Classification of Igneous Rock Series, Jour. Geol. Vol.39, p. 54-67, 1931.

26. Calaghan, Eugene, Some Features of the Volcanic Sequence in the Cascade Range in Oregon. Am. Geophysical Union, Vol. Sect. Tr. p. 243-249, 1933.

Table of Analyses

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
SiO_2	49.98	48.60	50.70	52.50	53.50	58.35	60.85	69.80	71.45	72.35	73.40
Al_2O_3	13.74	17.84	18.05	16.50	17.05	16.27	17.10	14.85	15.12	13.98	14.20
Fe_2O_3	2.37	1.84	1.62	4.00	2.41	1.01	2.18	1.07	0.95	0.60	0.24
FeO	11.60	1.20	6.96	6.88	8.50	7.38	4.30	2.37	1.78	0.60	1.76
MnO	0.24	0.30	0.40	0.40	0.20	0.15	0.20	Tr.			Tr.
TiO_2	2.87	1.30	1.30	2.45	1.80	1.15	0.90	0.30	0.30	0.25	0.20
CaO	8.21	11.65	9.70	8.30	7.40	6.30	4.35	2.00	1.70	1.30	1.35
MgO	4.73	7.90	7.60	3.92	3.72	3.07	2.21	0.36	0.34	0.30	0.18
K_2O	1.29	0.25	0.68	0.81	0.73	1.75	1.30	3.18	3.49	3.92	4.10
H_2O-	} 1.22	0.30	0.10	0.20	0.25	0.10	0.15	0.30	0.15	0.05	0.10
H_2O+		0.25		0.10	0.10	0.10	0.65	0.50	0.15	0.45	0.40
CO_2											
P_2O_5	0.78	Tr.	0.23	0.30	0.30	0.18	0.45	Tr.	Tr.	Tr.	Tr.
S	Tr.	Tr.	Tr.	Tr.	Tr.	n.d.	n.d.	Tr.	Tr.	Tr.	Tr.
	99.95	99.90	100.04	99.91	99.86	100.85	99.84	99.83	99.86	100.02	100.08

1. Average of six Oregonian plateau basalts; after H. S. Washington.
2. Gabbro; block from lithic tuff cone on south shore of East Lake, near resort.
3. Basalt; flow on Lava Top Butte.
4. Basalt; Double falls of Paulina creek.
5. Basalt; aphyric flow at the base of the Paulina Cliffs.
6. Andesite; glassy, porphyritic flow on fissure walls above East Lake
7. Andesite; scoriaceous flow at the mouth of Paulina Lake
8. Platy rhyolite; one mile south of East Lake resort.
9. Platy rhyolite; Lookout Station, summit of Paulina peak.
10. Obsidian; massive, black flow on north wall of crater, Big Pumice cone between the lakes.
11. Pumiceous obsidian; Plug-dome at head of Big Obsidian Flow.

All analyses by Frank Herdsman, except No. 1

Fig a, "Variation Diagram"

LEGEND

LP = LASSEN PEAK

CL = CRATER LAKE

S = SHASTA

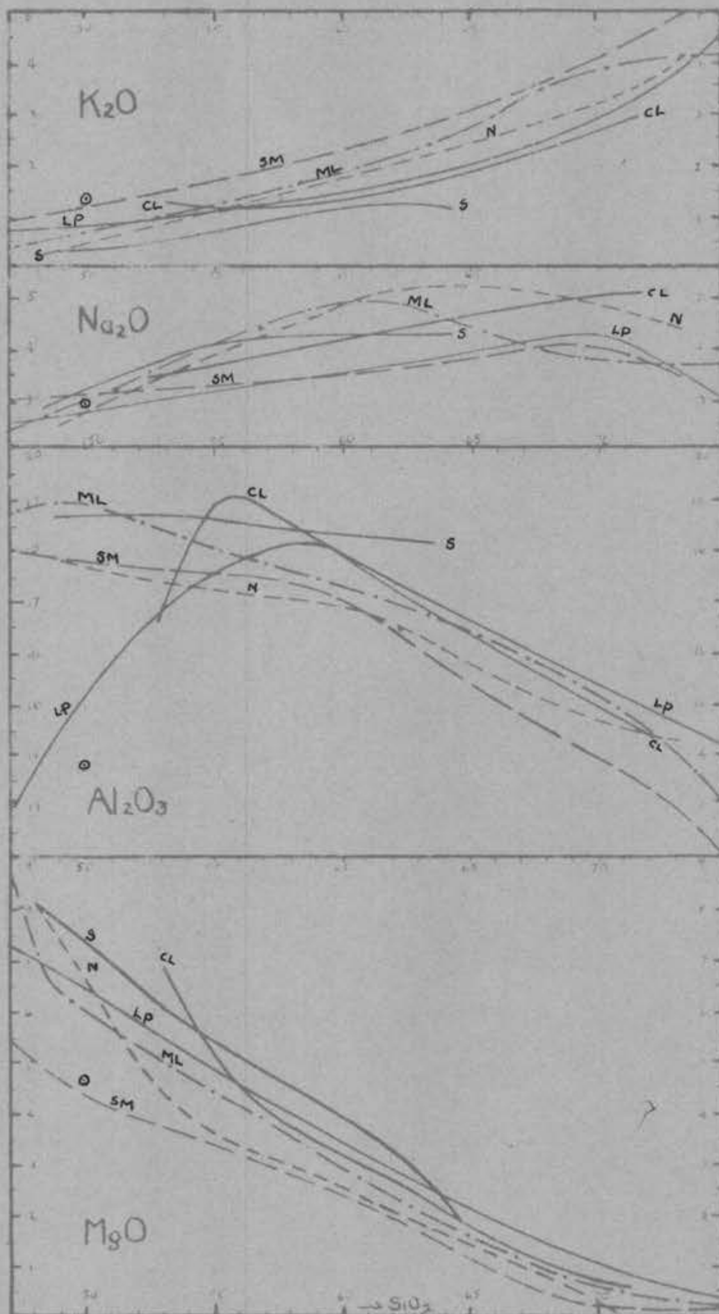
N = NEWBERRY VOLCANO

SM = STEENS MOUNTAIN

ML = MEDICINE LAKE

O = AVERAGE OREGONIAN PLATEAU BASALT

High Cascade Lavas in solid lines.



Williams

Fig. b. Variation Diagram

LEGEND

LP = LASSEN PEAK

CL = CRATER LAKE

S = SHASTA

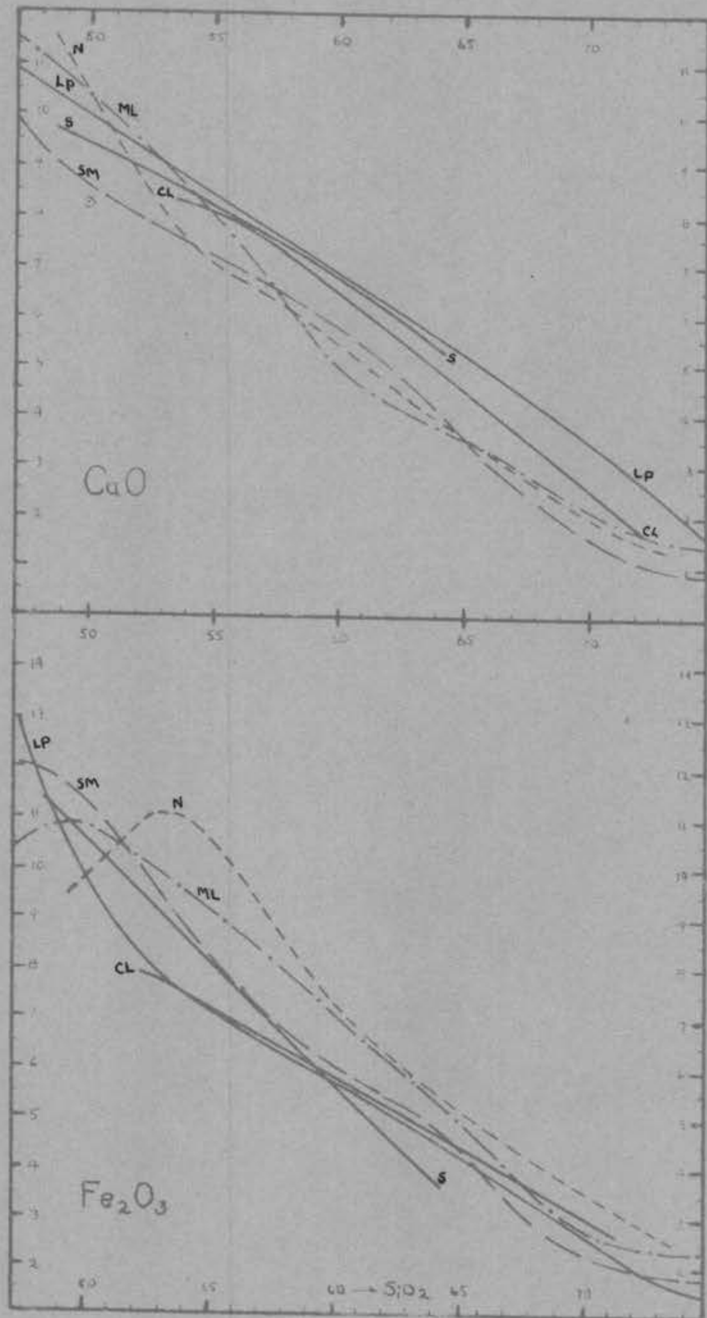
N = NEWBERRY VOLCANO

SM = STEENS MOUNTAIN

ML = MEDICINE LAKE

O = AVERAGE OREGONIAN PLATEAU BASALT.

High Cascade Lavas in solid lines.



Williams

Theoretical reasons for the above data are discussed as well as the explanation for the "remarkable basalt-rhyolite association."

> To summarize: "It is believed that the lavas of the Newberry volcano and of the High Cascade cones, although probably derived from a common plateau, basalt magma, differ fom each other chiefly as the result of crystal differentiation. The question as to whether or not the acid and the basic magmas of the Newberry volcano could have separated in the liquid state must remain unanswered, but with no positive evidence to the contrary, the possibility is inviting, and should not be discarded."

Williams, I. A. The Columbia River Gorge: Its Geologic History. Bureau of Mines & Geology Vol.2 No. 2, 1916.

113

(Content)

A more or less popular account of the general geology of the Portland area and the Columbia River gorge. Contains numerous photographs and a geologic section through the Cascade Mountains from Portland to The Dalles.

Wilkinson, W. D. The Petrography of the Clarno Formation of Oregon with Special Reference to the Mutton Mountains. University of Oregon (Doctor's Thesis) 1932

114

(Content)

The petrography of the igneous rocks of the Clarno Eocene of north central Oregon is treated in an exhaustive study.

A theory is advanced for the explanation of the formation of spherulites.

The occurrence of spherulites in the acid lavas of the Clarno is described.

The occurrence of the following igneous types is described:

Andesite	Lithoidite
Glass	Rhyolite
Nevadite	Pantellerite
Trachyte	Felsite
Orthopyre	

Willis, Bailey. Notes on the Geology of the Cascade Range, Oregon. Science 11:122, 1888

115 (Content)

"South of latitude 42°30' the Cascades' volcanic mass is supported on a slightly disturbed sedimentary base. North of latitude 46°30' the range of closely flexed sediments is dotted with volcanic cones. The difference is one of degree, not of kind; but the difference is great."

Region of southern Oregon spoken of as being an archipelago at one time, Diller and Dutton.

Further notes on the northern Cascades of Washington.

Winchell, A. N. Petrology and Mineral Resources of Jackson and Josephine Counties, Oregon. O.B.M.&G. Vol. 1, No. 5, 1914

116

(Content)

An account of the mines, mineral production, and general geology of Jackson and Josephine Counties.

Igneous Rocks

"Igneous rocks are abundant in Jackson and Josephine counties covering areas at least equal to those occupied by the sediments. They are intimately associated with the latter so that their age is closely known in some cases. They intrude, underlie or cover the sedimentary rocks in various instances. They are also of varied types petrographically, including abundant andesite and tonalite, some serpentine, auganite, rhyolite, and basalt, and less abundant pyroxenite, peridotite, vogesite, and still other types. Some of these rocks flowed out at the surface or formed masses of volcanic fragments which are interbedded with sediments. Others formed stocks, dikes, or sills at varying depths beneath the surface of previously formed sediments.

The earliest igneous rocks seem to be the Paleozoic interbedded andesites. These show their age quite clearly by their highly altered condition as "greenstones" as well as by their interbedded position. Bowlders derived from them form a large part of the overlying Cretaceous conglomerates.

There seem to be some interbedded flows and beds of andesitic type in the Jurassic sediments of Josephine county, but it is possible that these andesites are really sills rather than lavas or tuffs.

At the close of the Jurassic period igneous activity was very pronounced in this region. It began with the intrusion and extrusion of more andesitic greenstones and these were followed by very basic rocks now largely altered to serpentine. Then came the formation of the great Siskiyou tonalite batholith followed by minor intrusions of dacite and auganite. The last rock (called augite andesite) is reported to cut the Horsetown formation of the Lower Cretaceous in some places.

Petrology

The rocks found in Jackson and Josephine counties belong to many different types and include representatives of all the four chief divisions of rocks, that is, the igneous, the katamorphic, the sedimentary, and the anamorphic. These will be described in regular order after a brief statement of the methods used in studying them."

Analyses of Volcanic Rocks from Southwestern, Oregon.

Analysis of Volcanic Rocks From Southwestern Oregon

Sample No.	328	358	102	98	189	246	314	228
SiO_2..	73.70	55.92	55.76	51.38	47.40	49.02	48.68	37.92
Al_2O_3.	13.70	19.16	15.68	17.15	20.14	15.02	17.84	4.38
Fe_2O_3.	.70	1.94	1.49	1.12	.58	2.00	3.44	12.76
FeO...	2.14	4.76	6.43	6.54	6.64	8.40	6.54	11.18
MgO...	.74	5.27	6.36	6.18	6.34	7.06	7.94	16.60
CaO...	1.76	5.77	8.71	9.24	7.78	10.46	7.17	13.63
Na_2O..	4.28	3.26	1.86	2.72	2.76	3.12	4.06	.29
K_2O...	1.42	.38	1.18	.80	2.65	2.65	.27	.16
H_2O-..	.60	2.90	1.23	1.57	2.98	2.94	3.48	1.14
H_2O+..	.04	.06	.10	.10	.12	.08	.07	.06
CO_2...				.84				
TiO_2..	.34	.75	1.22	1.25	1.54	1.64	1.04	2.22
	99.42	100.67	100.02	98.89	98.93	99.91	100.42	100.26

No.328. Rhyodacite, Oriole Mine, Josephine Co., Ore.
No.358. Dacite porphyry, Almeda mine, Josephine Co., Ore.
No.102. Andesite, Opp mine, Jacksonville, Ore.
No. 98. Spessartite, Jacksonville quarry, Ore.
No.189. Spessartite, Braden mine, Jackson Co., Ore.
No.246. Auganite, Queen of Bronze mine, Josephine Co, Ore.
No.314. Auganite, Greenback mine, Josephine Co., Ore.
No.228. Magnetite pyroxenite, Whitney mine, Gold Hill, Ore.

Analyses of other Rocks From Southwestern Oregon

Sample No.	10	291	44	9	164	180	221
SiO_2...	72.76	60.04	81.10	67.78	65.98	47.42	53.24
Al_2O_3..	15.97	17.14	12.89	19.14	17.20	20.56	18.36
Fe_2O_3..	.90	2.00	1.64	.56	1.49	1.19	.64
FeO....	.52	3.68	.15	2.68	2.68	5.10	7.84
MgO....	.00	4.78	.07	.52	2.46	7.08	5.04
CaO....	1.26	6.25	.10	1.57	.11	14.04	9.67
Na_2O...	3.74	3.96	.28	1.65	2.18	1.80	3.47
K_2O....	3.34	1.04	.30	1.46	3.96	.66	.58
H_2O-...	.86	.88	4.16	3.12	2.56	1.36	.40
H_2O+...	.10	.06	.12	.38	.12	.08	.04
CO_2....				.70			
TiO_2...		.78			1.40	1.01	.70
	99.51	100.61	100.81	99.56	100.14	100.30	99.98

No. 10 Granite, White Point, Jackson Co., Ore.
No.201. Tonalite, near Wilderville, Josephine Co., Ore.

No. 44. Laterite, or kaolinized rhyolite, Walker creek, Jackson Co., Ore.
No. 9. Argillite, south of Siskiyou tunnel, Jackson Co., Ore.
No. 164. Argillite, Opp mine, Jackson Co., Ore.
No. 180. Contact rock, Galls creek, Jackson Co., Ore.
No. 221. "Greenstone" Harth and Ryan mine, Jackson Co., Ore.

Igneous Rocks

"Igneous rocks belong to three cheif classes, namely, those which crystallized with coarse grain at considerable depth, called plutonic rocks; those which solidified at or near the surface with finer often porphyritic, texture, called volcanic rocks; and those which formed dikes or similar intrusions, having aplitic or similar textures, called hypabyssal (or dike-) rocks.

Composition of Granite from White Point, Oregon
(S. W. French, analyst.)

SiO_2......	72.76
Al_2O_3.....	15.97
Fe_2O_3.....	.90
FeO.......	.52
MgO.......	.06
CaO.......	1.26
Na_2O......	3.74
K_2O.......	3.34
H_2O-......	.10
H2O+......	.86
	99.51

Calculated mineral composition

Quartz.............	32.80
Soda-orthoclase....	25.75
Oligoclase (Ab_4An_1)	31.20
Kaolinite..........	5.85
Biotite............	1.07
Magnetite..........	1.23
Al_2O_3, H_2O.........	1.62
	99.52

Composition of Tonalite from Southwestern Oregon

SiO_2...	58.25	60.04
Al_2O_3..	20.52	17.14
Fe_2O_3..	.68	2.00
FeO1...	3.88	3.68
MgO....	2.03	4.78
CaO....	7.88	6.25
Na_2O ..	4.25	3.96
K_2O....	.50	1.04
H_2O....	1.10	.88
H_2O+...	.24	.06
TiO_2...	.57	....
ZrO ...	.01	....
P_2O_5...	.16	....
MnO....	.10	....
	100.17	100.61

Approximate mineral composition

	I	II
Andesine (near Ab An)....	62.9	......
Andesine (near Ab An).....	....	45.6
Quartz..........	13.8	18.0
Hornblende......	16.0	22.9
Biotite.........	5.6	11.9
Titanite........	....	.5
Magnetite.......	....	.3
Apatite, ilmenite, alumina, water..........	1.6	1.4
	99.9	100.6

I. Tonalite from Umpqua river, Ore. G. Steiger, analyst. U.S.G.S. Bull. 419, p.167

II. Tonalite (sheared) near Wilderville, Ore. S. W. French, analyst.

Composition of Gabbro from Southwestern Oregon
(H. N. Stokes, analyst.[1])

SiO_2.......	56.45
Al_2O_3......	13.81
Fe_2O_3......	1.73
FeO........	3.95
MgO........	8.67
CaO........	6.69
Na_2O.......	5.03
K_2O........	.46
H_2O-.......	2.02
H_2O+.......	.67
TiO_2.......	.31
P_2O_5.......	.02
SrO........	.02
	99.83

Composition of Peridotite from Southwestern Oregon
(F. W. Clarke, (?) analyst.[2])

SiO_2........	41.43
Al_2O_3.......	.04
Fe_2O_3.......	2.52
FeO.........	6.25
MgO.........	43.74
CaO.........	.55
Ignition....	4.41
Cr_2O_3.......	.76
NiO.........	.10
	99.80

Approximate mineral composition

Olivine.......	70.7
Pyroxene......	19.9
Magnetite.....	4.7
Chromite......	4.7
Water, Etc....	4.5
	99.8

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1. U. S. Geol. Survey Bull. 419, p. 170
2. Same.

Composition of Auganite from Southwestern Oregon

	I	II
SiO_2	48.68	49.02
Al_2O_3 ...	17.84	15.02
Fe_2O_3 ...	3.44	2.00
FeO.....	6.54	8.40
MgO.....	7.94	7.06
CaO.....	7.17	10.46
Na_2O....	4.06	3.12
K_2O.....	.16	.27
H_2O-....	3.48	2.94
H_2O+....	.07	.08
TiO	....	....
P_2O_5	....	....
SrO.....	....	....
BaO.....	....	....
	100.42	100.01

I. Auganite, 5th level, Greenback mine. S.W. French, analyst.
II. Auganite ("hypersthene-augite andesite"), Llao Rock, Crater lake, Ore. H.N. Stokes, analyst. U.S.G.S. Bull. 419, p. 168
III. Auganite, north end adit, Queen of Bronze mine. S.W. French, analyst.

Westgate, L. G. Deposits of Chromite in Eastern Oregon. U.S.G.S. Bull. 725, 1921.

117 (Content)

"Granodorite was intruded into the Elkhorne range north of Sumpter, west of Greenhorn, and further southwest both north and south of the John Day River. Gabbros and peridotites also cut sedimentaries in places."

Lindgren refers to these peridotites as follows:

"This rock which is rarely found in Idaho and Montana begins to appear in force as the pacific province of intrusive rocks is reached.
Peridotite forms large areas in the Strawberry Range south of Prairie and Canyon."

Chrom-bearing serpentine belts of Grant and Baker

Counties mapped.

Zimmerman, D. Z. Geology of the Long Tom Area. University of Oregon Thesis. 1927

118

(Content)

(Igneous Rocks)

"Igneous rocks occur throughout the formation as dikes and sills. The groundmass varies from fine to medium coarse grained. A few of the rocks are porphyritic, but porphyritic texture is not common except in a small range in size producing seriate porforoid as the most typical texture. Basalt, hawaiite, and quartz andesite are the most common igneous rocks. The igneous rocks are vary rarely vesicular and then chiefly along the edges of a sill. When vesicules do occur they have often been filled either by zeolites or calcite producing an amygdaloidal texture."

The following igneous rocks were taken as samples and have been petrographically described in the text and appear with photomicrographs.

1. Basalt
2. Quartz diabase
3. Quartz diabase
4. Quartz andesite
5. Quartz diorite
6. Andesite
7. Quartz andesite
8. Quartz andesite
9. Dacite porphyry
10. Quartz andesite
11. Olivine santorinite
12. Andesite
13. Gabbro

PART II

Comparison of a certain selected suite of Oregon's Igneous rocks in relation to rocks from world famous localities.

Introduction to Part II

Part II consists of a study of the comparison of a certain selected suite of igneous rocks from the Cascade Mountains of north central Oregon to rocks collected from world famous localities and studied by authorities in the field of petrography. The study represents an attempt to determine what similarities and differences exist between the two groups of rocks.

The following method of comparison was used in this study. First all hand specimens of the rocks under consideration were collected and examined for similarities. Of the several hundred thus compared about forty apparent similarities were discovered. This number was cut to about twenty by a more detailed examination with the hand lense. Those of the remaining group were compared in detail under the microscope. The list of rocks thus treated as well as the details of comparison are to be found on the following pages.

TABLE OF APPARENT IDENTITIES

Cascade Rocks				Foreign Rocks	
Type:	Colored	No.	Number	Name	Locality
V	White	0-611........	T-10:11	Andesite	Mt. Shasta, Cal.
V	White	As-796........	T-10:16	Andesite	Hood River, Ore.
V	White	3s-122........	T-10:11	Andesite	Mt. Shasta, Ore.
V	White	AR-963........	K-196	Mica Andesite	
V	White	AR-963..........	K-117	Gauteiite.	
V	White	AG-973..........	K-199	Hornblende Andesite	
V	White	AB-469..........	W-41	Granodiorite?	Mary's Peak Oregon
V	White	AD-706..........	T-5:5	Augite Diorite.	Little Falls, Minn.
V	White	AS-21...........	K-171	Trachyte.	
V	White	AR-739c........	T-10:6	Andesite,	Mt. Shasta, Cal.
V	White	AA-732.........	HK-79	Trachyte,	Rhineland
V		AA-728.........	K-206	Hypersthene Andesite	
V		AA-677g........	K-206	Hypersthene Andesite	
III		AB-945a........	K-207	Hypersthene Andesite	
III		AB-945c........	HK-79	Trachyte	Rhineland
III		AB-482.........	HK-55	Rhomben Porphyry	
III		AB-619.........	K-139	Spessartite	

O-611 Type V

Texture: porphyritic hiatal

3 distinct generations of crystallization.

(3) Plagioclase
20%
Large phenocrysts
45% small laths.
Labradorite
Andesine
Basic labradorite
Bytownite?
Some large phenocrysts have inclusions of glass.

About equal amounts of andesine and labradorite.

(2) Hypersthene-10% in oblong tabular crystals and in irregular grains.

(1) Magnetite-5% in medium grains to minute particles.

(4) Groundmass made up of laths of andesine and small grains of other plagioclase, laths and fragments of hypersthene, the instertital spaces being filled with magnetite particles and yellowish brown glass.

T10:11

Hypersthene Andesite-Mt. Shasta.

Locality type described as follows in U.S.G.S. Bull. 150 P.227--Diller.

Texture: porphyritic

Brick shaped crystals of feldspar and hypersthene are seen throughout a light grey groundmass. The feldspar is clear and colorless, showing polysynthetic twinning and zones of growth. It is all plagioclase apparently and the angle of extinction as well as its composition judging from the analysis indicate that it is labradorite.

Hypersthene occurs in irregular grains and oblong crystals like those in the Hyp. Andesites of Buffalo Peak, Colorado. As it is sometimes included in the feldspar, some of the Hypersthene must have crystallized before the feldspar.

Occasionaly dark spots are found to be composed chiefly of magnetite and pyroxene and suggests the former presence of Hornblende.

The groundmass contains much glass clouded by a multitude of the feldspar microlites and minute grains or pyroxene and magnetite.

Analysis of Hyp. And. from Mr. Shasta, Cal.

SiO_2..64.5	Fe_2O_3.. .9	K_2O...1.2
Al_2O_3.18.3	FeO....2.5	Na_2O..2.5

AS-796

Texture: ophitic-graphic

Minerals:

(1) Magnetite 8% in rounded grains .1 x .1 m.m. to lath shaped massed .5 x .5 m.m., some irregular and embayed. Some are incompletely altered from hypersthene. Some are also intersertal--apparently a continued crystallization of magnetite took place.

(2) Olivine 15%
in subhedral grains from .1 x .1 m.m. up to 1 x 1 m.m. The larger phenocrysts being anhedral. Yellow stain olong cleavage crack denotes slight alteration to Fayalite. Small grains of augite and plagioclase can be seen to be flowing around grains of Olivine.

(3-4) Plagioclase 50%
Dominantly andesene and labradorite in the ratio of about 2/3 to 1/3.
Lab. .5 x .1 m.m.
And. .2 x .05 and up.

(3-4) Augite 27%
Graphically intergrown with plagioclase. Fine intersertal grains up to 2 x 1 m.m. Large anhedral crystals of augite acting as hosts for many small plagioclase laths.

T10:16

Andesite--Hood River, Oregon
Texture: ophitic to graphic.

Minerals:

(1) Magnetite 10%
in original constituent, fine grains up to .4 m.m. diameter, angular shape.
Some, irregular secondary, altering from hypersthene.

(2) Olivine 5%
1 x 1 m.m., subrounded embayed, alteration to limonite taking place along cleavage cracks.

(3) Plagioclase 50%
$\frac{3}{4}$ labradorite in prismatic laths, up to .5 m.m. x .1 m.m.
$\frac{1}{4}$ andesine in laths and grains.
Euhedral Bytownite, rare in wide rectangular grains, corrode, apparently the first of the spars to crystallize.

(4) Augite 35%
in large grains 1.5 x .7 m.m. ophitically to graphically intergrown with the spars.

Conclusions:

1. These two rocks are similar in almost every detail.
2. The spars in T10:16 are apparently more basic than in AS -796.

Oregon Rocks

3S-122

Type V

Texture: Seriate homoid.

A slowly and regularly cooled rock. Contains long irregular runs of glass.

Minerals:

(1) Magnetite 12%
In minute grains many of which are included in the feldspars. Occasionally in larger and irregular drains.

(2) Plagioclase
In long slender laths, for the most part exhibiting parallel extinction. Many show zonal growth of a single marginal zone giving extinction angles up to 45°. Average is apparently andesine. Some labradorite.

There is no distinct hiatus between groundmass and phenocryst.

Glass 15% some containing fine magnetite dust or bubbles.

T10:11

Hyp. And. Mt. Shasta

Locality type described as follows in U.S.G.S. Bull. 150 P. 227, by Diller.

Texture: Porphyritic.

Brick shaped crystals of feldspar and hypersthene are seen throughout a light grey groundmass. The feldspar is clear and colorless showing polysynthetic twinning and zones of growth. It is all plagioclase apparently and the angle of extinction as well as its composition judging from the analysis indicate that it is labradorite.

Hypersthene occurs in irregular grains and oblong crystals like those in the Hyp. Andesites of Buffalo Peak Colorado. As it is sometimes included in the feldspar some of the Hypersthene must have crystallized before the feldspar.

Occasionally dark spots are found to be composed chiefly of magnetite and pyroxene and suggests the former presence of hornblende.

The groundmass contains much glass clouded by a multitude of feldspar microlytes and minute grains of pyroxene and magnetite.

Analysis:

SiO_2...64.5	CaO...5.1
Al_2O_3..18.3	MgO...2.3
Fe_2O_3.. .9	K_2O...1.2
FeO.... 2.5	Na_2O..4.6

AR-963

Type V

Texture: porphyritic.

Minerals:

(1) Magnetite 7% in minute grains up to .4 m.m. included in spars and hornblende.

(2) Plagioclase 65%
Apparently made up of phenocrysts of andesene and labradorite in the ratio of 3 andesine to 4 labradorite.

(3) Hornblende 5% unaltered.

(4) Hypersthene 7%
in tabular phenocrysts.

(5) Glass

K117

Gauteite

Texture: porphyritic groundmass trachytic.

Described by Krantz as follows:

The groundmass ic composed of lath shaped sanidine, green or leather colored crystals of augite, brown prisms of hornblende and black grains of magnetite and contains plagioclase in phenocrysts, green or yellowish grey crystals of augite, brown hornblende, titanite with roughened surface, colorless prisms of apatite, analcime, colorless, filling up the cavities.

Oregon Rock

AR-963

Type V

Texture: porphyritic

Minerals:

(1) Magnetite 7%
In minute grains up to .4 m.m., included in spars and hornblende.

(2) Plagioclase 65%
Apparently made up of phenocrysts of andesine and labradorite in the ratio of about 4 labradorite to 3 of andesine.

(3) Hornblende 5%, unaltered.

(4) Hypersthene 7%
In tabular phenocrysts.

Glass 15%

K-117

Gauteiite

Texture: porphyritic groundmass trachytic.

Described by Krantz as follows:

The groundmass is composed of lath shaped sanidine, green or leather colored crystals of augite, brown prisms of hornblende, and black grains of magnetite, and contains plagioclase in phenocrysts, green or yellowish grey crystals of augite, brown hornblende, titonite with roughened surface, colorless prisms of apatite, analcime, colorless, filling up the cavities.

Oregon Rock

AG-973

Texture: Microporphyritic seriate.

Minerals:

(1) Magnetite 8%
In fine grains up to 1.5 m.m. in diameter.

(2) Plagioclase
Phenocrysts 55%
Dominantly andesene and labradorite in about equal proportions. The larger more perfect phenocrysts are andesine. The smaller, darker grey are labradorite.
And. 1 x.8 m.m.
Lab. .5 x .2 m.m.

(3) Hypersthene 2%
Small scattered tabular prisms, some exhibiting heavy cleavage cracks.

Groundmass: 50%
Magnetite dust, minute feldspar grains, and green glass.

K-199
Hornblende andesite
Warkenburg, Seven Mts., Renish, Prussia.

Texture: Microporphyritic

Minerals:

(1) Magnetite 8%
Phenocrysts up to .3 m.m. diameter, also in fine grains and dust making up 30% of groundmass.

(2) Plagioclase
Phenocrysts 25%
Dominantly basic labradorite. Groundmass may be seen to be flowing around plagioclase phenocrysts.
Andesene laths up to .05 m.m. make up 60% of the groundmass the remainder being magnetite 30% and green glass.

(3) Biotite 9%
In tabular prisms .6 x .4 m.m., ends fringed and stained black,

(4)? Hornblende 1%
.1 m.m. in diameter, anhedral, badly resorbed and corroded.

(5)? Augite 2%
Some euhedral phenocrysts .4 x .2 m.m.
Apatite, accessory, minute inclusions in the spars.

Oregon Rock

AB-469

Texture: ophitic

Minerals:

(1) Magnetite: 10%
Fine grains up to masses .3 m.m. in diameter.

(2) Olivine 15%
In a irregular anhedral masses ranging from small grains up to .7 x .7 m.m. A large percentage of it exhibits a reddish iron stain in part, probably represents an alteration to Fayalite. Some Fayalite? is independent of the olivine.

(3) Plagioclase 50%
The bulk of which are long slender laths 1.2 x .2 m.m. exhibiting corroded edges, some up to 2 m.m. in length. It is dominantly andesine and labradorite in the ratio of about 1 to 3 but a small isolated group of bytownite seems also to be present.

(4) Augite 25%
Is graphically intergrown with feldspar laths, some are completely included. Masses up to 2 m.m. in diameter.

W-41
Granodiorite?
Mary's Peak, Oregon

Texture: Granitic-equigranular.

Minerals:

(1) Magnetite 10%
Anhedral irregular masses up to .5 m.m. in diameter.

(2) Augite:
Subhedral prisms .6 x .3 m.m. and anhedral grains subrounded corroded and altered, 1.5 m.m. in diameter.

(3) Plagioclase 40%
Dominantly labradorite and andesine in about equal proportions. Andesine in euhedral prisms up to 2.5 x .5 m.m.

(4) Quartz 20%
Some intersertal anhedral masses, badly altered, some shattered and resorbed to a high degree.

(5) Green hornblende?
In tabular and assicular prisms.

AD-706

Type V

Texture: porphyritic

Minerals:

(1) Magnetite 2%

(2) Plagioclase 50%
Phenocrysts, angular fragments to subhedral and brick shaped.
Andesine and labradorite in the ratio of about 2 to 3 respectively.

(3) Augite 20%
In rounded irregular grains to subhedral phenocrysts, yellow to leather colored.

(4) Groundmass, fine dark grey, composed of minute grains of laths of feldspar and glass.

T4-17
Dolerite: Mt. Hope, Md.

Texture: Granitic holocrystallin.

Minerals:

(1) Magnetite 10%
Large groups of phenocrysts are to be found in juxtaposition separated by open leads of glassy groundmass.

(2) Plagioclase 63%
Phenocrysts in juxtaposition.
Labradorite and andesine in the ratio of about 3 to 1 respectively.

(3) Augite 12%

(4) Biotite 15%

AS-21

Texture: Trachytic

Minerals:

(1) Magnetite 10%
Scattered angular fine grains.

(2) Olivine 15%
Rounded to euhedral phenocrysts, large up to 1.7 x .7 m.m. Phenocrysts exhibit a brown rim of alteration probably Fayalite. Smaller plagioclase laths can be seen flowing around the larger phenocrysts.

(3) Plagioclase 60%
In ophitic laths, average .5 x .1 m.m. Larger phenocrysts rare. Dominantly labradorite and andesine in the ratio of about 4 to 1 respectively.

(4) Glass 12%
In irregular disconnected masses.

K-171
Trachyte: Mt. Dore Auvergene

Texture: Porphyritic.

Minerals:

(1) Magnetite: Fine rounded grains making up 20% of the groundmass. Inclusions in augite and in rounded phenocrysts up to .2 m.m.

(2) Augite: rounded green phenocrysts 1.2 x .6 m.m. 15% phenocrysts, small to minute grains and laths make up 30% of the groundmass.

(3) Plagioclase: 25%
Phenocrysts ranging from basic to acid andesene. Phenocrysts up to 1 m.m. in diameter. Groundmass 50% holocrystallin andesene.

AR-739c

Texture: Porphyritic holo-crystallin.

Minerals:

(1) Magnetite: Fragments up to .2 m.m. and fine particles.

(2) Plagioclase 50%
Labradorite and andesene about equal. Orthoclase? rare.

(3) Augite 3%
A few scattered rounded crystals.

(4) Hypersthene 5%
Tabular elongate also irregular fragments.

(5) Biotite 10%
Altering to magnetite.

Groundmass 30%
Spars 20%
Pyroxene 10%
Magnetite
Glass.

T10:6
Andesite: Mt. Shasta, Cal.

Texture: Porphyritic.

Locality type described as follows in U.S.B.S. Bull. 150:

Brick shaped crystals of feldspar and Hypersthene are seen throughout a light grey groundmass. The feldspar is clear and colorless showing polysynthetic twinning and zones of growth. It is all plagioclase and the angle of extinction as well as its composition judging from the analysis indicate that it is Labradorite.
Hypersthene accurs in irregular grains and oblong like those in the Hyp. Andesites of Buffalo Peak, Colorado. As it is sometimes included in the feldspar some of the Hypersthene must have been crystallized before the feldspar.

Occasionally dark spots are found to be composed chiefly of magnetite and pyroxene and suggests the former presence of hornblende.

The groundmass contains much glass clouded by a multitude of feldspar microlites and minute grains of pyroxene and magnetite.

Analysis:		Norm	
SiO_2	64.5	q	17.52
Al_2O_3	18.2	or	6.67
Fe_2O_3	.9	ab	33.01
FeO	2.5	an	27.52
CaO	5.1	di	1.76
MgO	2.3	hy	9.85
K_2O	1.2	mt	3.25
Na_2O	4.6		

Oregon Rock

AA-732

Texture: Porphyritic
Only one generation of phenocrysts in a fine but holocrystallin groundmass.

Minerals:

(1) Magnetite 15%
Some of which is secondary.

(2) Hypersthene 15%
Tabular prisms including magnetite. Much of the hypersthene is altered, many phenocrysts showing a rust colored rim possibly hematitic. Some is included in magnetite or else is an alteration phenomena, hypersthene-magnetite.

(3) Plagioclase 50%
Andesene and labradorite in about equal proportions. Some bytownite?

(4) Hornblende 3%
Duteric corroded phenocrysts.

(5) Augite 10%
Some badly altered apparently to magnetite.

HK-79
Trachyte, Rhineland

Texture: Seriate porphyroid.

Minerals:

(1) Magnetite 7%
Some not completely altered.

(2) Plagioclase 30%
Phenocrysts altered to subhedral many partly resorbed and embayed.
Dominantly andesene and oligoclase.
Orthoclase 2%
Quartz? 1%

Diobside, in small tabular prisms, 1%.

Enstatite present as an accessory mineral.

(3) Biotite 5%
Rounded to prismatic flakes some badly resorbed. Some spherulitic inclusions. Small apatite inclusions in biotite.

(4) Glass 20%
In groundmass also magnetite dust and feldspar grains.

AA-728

Texture: Porphyritic Seriate.

Minerals:

(1) Magnetite 15%
In fine grains and medium grains. Some alteration products.

(2) Hypersthene 17%
In tabular and diamond shaped crystals. Rims stained black, altering to magnetite.

(3) Plagioclase: Phenocrysts 30% in large rectangular prisms and laths up to 2 x .3 m.m. Dominantly labradorite but some andesine is present. Fine minute laths of andesene make up 60% of the groundmass.

(4) Glass: a small percentage in the groundmass.

K-207
Hypersthene Andesite
Tokay, Hungary

Slide indeterminant--described by Krantz as follows: Pg.69.

The groundmass is composed of dark grey or brown glass with lath shaped crystals of plagioclase. And very minute prisms of pyroxene, probably hypersthene. The phenocrysts of plagioclase are clear and colorless, and contain numerous inclusions of glass and groundmass; hypersthene well crystallized, pleochroism distinct but weak, augite similar to the former but exibiting no pleochroism and no straight extinction; biotite, brown, strongly pleuchoric; hornblende sparingly, brown with opaque margin; black grains of magnetite.

Oregon Rock

AA-677g

Texture: Hyperhyalin

Minerals:

(1) Magnetite 8%
Rounded irregular grains of varying sizes.

(2) Hypersthene 20%
Tabular prisms up to .5 x .3 m.m. usually associated with magnetite.

(3) Augite 3%
Tabular prisms .4 x .2 m.m.--small rounded grains.

(4) Plagioclase 30%
In small grains and laths not over .5 m.m. in length.

Laths and larger flakes range from basic labradorite to basic andesene.

Groundmass--light grey, composed of minute flakes of feldspar and glass with a few grains of hypersthene.

(5) Glass: Dominant constituent in locallized areas.

K-207
Hypersthene Andesite
Tokay, Hungary

Slide indeterminant--described by Krantz as follows: Pg.69

The groundmass is composed of dark grey or brown glass with lath shaped crystals of plagioclase. And very minute prisms of pyroxene, probably hypersthene. The phenocrysts of plagioclase are clear and colorless, and contain numerous inclusions of glass and groundmass; hypersthene well crystallized, pleochroism distinct but weak, augite similar to the former but exibiting no pleochroism and no straight extinction; biotite, brown, strongly pleuchoric; hornblende sparingly, brown with opaque margin; glack grains of magnetite.

Oregon Rock

AB-945a

Texture: Hyaloporphyritic.

Minerals:

(1) Magnetite: 20%
Highly altered making up dominant component of groundmass. Megascopically the rock is red due to the alteration of Fe.

(2) Plagioclase 60%
Two generations of phenocrysts: the larger .8 x .4 m.m., rectangular, apparently all labradorite. One example of an alteration rim containing small grains of second generation magnetite--then the crystal continued to grwo normally. Larger phenocrysts broken up and floated off by the apparent intrusion of glass.
Smaller second generation is apparently all andesene, in minute laths up to .2 m.m. in length. Intermediate sizes seem to be both andesene and labradorite.

(3) Glass 20%
Irregular leads and runs throughout mass.

K-207
Hypersthene Andesite
Tokay, Hungary

Slide indeterminant--described by Krantz as follows: Pg. 69

The groundmass is composed of dark grey or brown glass with lath shaped crystals of plagioclase. And very minute prisms of pyroxene, probably hypersthene. The phenocrysts of plagioclase are clear and colorless, and contain numerous inclusions of glass and groundmass; hypersthene well crystallized, pleochroism distinct but weak, augite similar to the former but exibiting no pleochroism and no straight extinction; biotite, brown, strongly pleuchoric; hornblende sparingly, brown with opaque margin; black grains of magnetite.

Oregon Rock

AB-954c

Texture: Porphyritic-sempatic

Minerals:

(1) Magnetite 4%

(2) Plagioclase 50%
Phenocrysts large, subhedral, zonal structure prominent.
Andesene and labradorite in about equal proportions. Rare crystals of oligoclase.

(3) Hypersthene 10%
In long tabular prisms, some altered to magnetite around rims. Inclusions of magnetite and feldspar.

Augite: trace.

Groundmass 16%, dark, composed of andesene laths, other plagioclase particles, and magnetite dust.

HK-79
Trachyte, Rhineland

Texture: Seriate porphyroid.

Minerals:

(1) Magnetite 7%
Some not completely altered.

(2) Plagioclase 30%
Phenocrysts altered to subhedral many partly resorbed and embayed.
Dominantly andesene and oligoclase.

Orthoclase 2%
Quartz? 1%

Diobside, in small tabular prisms, 1%.

Enstatite present as an accessory mineral.

(3) Biotite 5%
Rounded to prismatic flakes some badly resorbed. Some spherulitic inclusions. Small apatite inclusions in biotite.

(4) Glass 20%
In groundmass also magnetite dust and feldspar and grains.

Oregon Rock

AB-482

Texture: Seriate-homoidal trachyte.

Minerals:

(1) Magnetite: 18%
Anhedral irregular grains.

(2) Augite 30%
Small rounded subhedral grains exhibiting high relief.

(3) Olivine 5%
Euhedral to subhedral grains some partially resorbed .3 x .2 m.m.

(4) Plagioclase 45%
Regular series from minute slender laths up to 1.5 m.m.: essentially labradorite and andesene in the ratio of about 3 to 1 respectively.

(5) Glass 2%
Green in non-polarized light.

Accessory minerals:
Basaltic hornblende, a few scattered rounded grains.
Small apatite inclusions.

HK-55
Rhomb Porphyry

Texture: Porphyritic
Groundmass mermyketic.

Minerals:

(1) Magnetite 10%
Black irregular grains.

(3) Augite 30%
Anhedral, mostly widely disseminated throughout mass, spars seem to be included in some.

(2) Feldspars 40%
Phenocrysts very large, 4 m.m. and up, intensely corroded, and containing many fine inclusions of augite and magnetite. (Potash-soda variety).
Orthoclase makes up about 50% of groundmass. Phenocrysts lath shaped, 1 x .2 m.m.

(4) Biotite 1%
Small rounded grains.
Pseudomorphs after olivine.

(5) Quartz 5%
Intersertal rounded.

AB-619

Texture: Ophitic, diabasic.

Minerals:

(1) Magnetite 3%
Irregular grains and inclusions up to .3 m.m. maximum diameter.

(2) Augite 35%
In grains up to .5 m.m. in diameter. All anhedral sections, some slightly resorbed, occurs diabasically with the smaller plagioclase laths.

(3) Plagioclase 60%
Crystallization continued over considerable period in the fine laths, up to 1 x .1 m.m. The larger, older? generation of phenocrysts is dominantly labradorite, the younger generation, smaller, being andesine in the proportion of about 3 and 4 respectively.
Apparently some oligoclase.

(4) Glass: green, yellow, and colorless. Some of the green variety is seen to be included in augite and may antidate it. A rim composed of spherulitic growth is seen encircling bodies of yellow variety.

K-139
Spessartite, Camptonite
Stengerts, Spessart Mts.
(a Hornblende basalt)

Minerals:

(1) Magnetite 5%
Fine rounded grains.

(2) Hornblende 50%
Mostly green, badly resorbed containing much included magnetite.

Biotite 5%
Intergrown to a considerable extent with hornblende partially resorbed.

(3) Plagioclase 20%
Well intergrown with green hornblende, must have crystallized at about the same tim. Chracteristic laths few, resorbed and redissolved to a considerable extent, variety indeterminant.

Orthoclase 8%
Anhedral small grains.

Quartz 10%
3 Colorless grains apparently of the alpha variety.

Described by Krantz, Pg. 52:
Panidiomorphic groundmass. Composed of plagioclase with lamaller twinning, orthoclase, not twinned; hornblende, yellowish brown to green, with darker colored margin, often twinned; biotite, brown sometimes intergrown with hornblende; quartz, perfectly clear and colorless; magnetite, black grains.

Summary of Results

From an examination of the foregoing comparitive descriptions it is seen that there is a marked disimilarity mineralogically, among those types compared. The only exception to this disimilarity was shown in the case of thin sections No. As 796 and B:10:16, but that is only to be expected since the locality of the latter is Hood River, Oregon.

Comparitive tables of analyses show the Cascade rocks to differ but little chemically from similar rocks of other neighboring Pacific volcanic fields, thus suggesting similar magmas. It is therefore probable that the variation noted is chiefly due to crystal differentiation.

The extent of the chemical variation between the Cascade rocks and neighboring volcanic fields is shown graphically in the "Variation diagrams" Figs. (a) and (b), after Howell Williams[1].

Note: A further discussion of these conclusions is found in the Introductory summary page.

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1. Williams, Howell Newberry Volcano of Central Oregon. B.G.S.A. Vol. 46, No. 2 Feb. 1935.

TABLE I

Rock Name	Ref. No.	Type	Authority	Locality
ANDESITE		HYPERSTHENE		
Andesite*	17	Hypersthene	Calkins, F. C.	Hald's Canyon
Andesite*	32	Hypersthene	Diller & Patton	Crater Lake
Andesite*	21	Hypersthene-augite tonalose	Diller-Clarke	Northwest portion of Crater rim, Crater Lake.
Andesite*	21	Hypersthene-augite tonalose	Diller-Clarke	Wizard Island
Andesite*	21	Hypersthene-augite tonalose	Diller-Clarke	Palisades, Crater Lake
Andesite*	21	Hypersthene-augite tonalose	Diller-Clarke	"The Watchman" Crater Lake
Andesite*	21	Hypersthene-augite tonalose	Diller-Clarke	Lake level under Llao Rock, Crater Lake
Andesite*	19	Basic	Cambell, I.	McKenzie River
		AUGITE-HORNBLENDE		
Andesite*	21	Augite, auverguose	Diller-Clarke	South bank Umpqua 3/8 mile west of Day's Creek.

* Denotes chemical analysis.

TABLE I (cont.)

Andesite	33	Augite	Diller, J.S.	Applegate Region
Andesite*	18	Augite	Callaghan, E.	South Grouse Mt., Bohemia
Andesite	63	Pyroxene	Handly, H.W.	North central, Ore.
Andesite	63	Hornblende	Handly, H.W.	North central, Ore.
Andesite	85	Feldspar, hornblende	Lindgren, W.	Blue Mts.
Andesite, Eocene	17	Pyroxene	Calkins, F.C.	Hald's Canyon
Andesite, Eocene	17	Hornblende	Calkins, F.C.	Hald's Canyon
Andesite, Eocene	17	Hornblende-hypersthene	Calkins, F.C.	Clarno's Ferry
Andesite	17	Hornblende	Calkins, F.C.	Clarno's Ferry
Andesite	17	Pyroxene	Calkins, F.C.	Clarno's Ferry
QUARTZ				
Andesite	117	Quartz	Zimmerman, D.Z.	Long Tom area
Andesite	116	Quartzite	Winchell, A.N.	Gold Ridge Mine, Gold Hill
Andesite	112	Glassy	Williams, H.	Newberry Crater
Andesite	112	Glassy	Williams, H.	On fissure walls above East Lake.

TABLE I (cont.)

LABRADORITE				
Olivine Andesite	1	Olivine 10% Plagioclase 45%	Allen, J.E.	Columbia Gorge
Andesite*	18	Labradorite	Callaghan, E.	Top of Gold Hill, Blue River district.
Andesite*	18	Labradorite	Callaghan, E.	Near Grizzly Saddle, Bohemia district.
Andesite, black*	18	Labradorite	Callaghan, E.	McNeil Creek, Jackson County
Andesite*	18	Labradorite	Callaghan, E.	Bohemia Mt.
OLIVINE FREE				
Andesite	1	Olivine free	Allen, J.E.	Columbia Gorge
Andesite, trachytic	1	Olivine free Plagioclase 50-60%	Allen, J.E.	Columbia Gorge
Pyroxene andesite	1	Olivine free Plagioclase 50-60%	Allen, J.E.	Columbia Gorge
UNDIFFERENTIATED				
Andesite	26	Undifferentiated	Diller, J.S.	½ mile SE of Musick, Bohemia
Andesite	26	Undifferentiated	Diller, J.S.	Near McKenzie Fork, Blue River Region

TABLE I (cont.)

Andesite, Eocene	17	Undifferentiated	Calkins, F.C.	Cherry Hill
Andesite	112	Scoreaceous	Williams, H.	Flow at mouth of Paulina Lake
Andesite, trachytic	85	Altered	Lindgren, W.	Blue Mts.
Andesite	117	Undifferentiated	Zimmerman, D.Z.	Long Tom area
Andesite	116	Undifferentiated	Winchell, A.N.	Opp Mine, Jacksonville, Oregon
Andesite	108	Undifferentiated	Tuck, R.	Blue River Mining region
Andesite	2	Undifferentiated	Anderson, F.M.	West of Talant
Andesite	7	Undifferentiated	Bames & Butler	Columbia Gorge
Andesine porphyry	1	Plagioclase 75% Augite 73%	Allen, J.E.	Columbia Gorge
Andesine vitrophyre	1	Olivine free Plagioclase 40-60%	Allen, J.E.	Columbia Gorge
Aplite	85	Undifferentiated	Lindgren, W.	Blue Mts.
Aphlite	57	Undifferentiated	Goodspeed, G.E.	Cornucopia
Augitite	53	Labradorite	Frazer, D.M.	Oakridge-Cresent
Auganite*	116	Undifferentiated	Winchell, A.N.	Queen of Bronze Mine, Josephine County.

TABLE I (cont.)

Auganite*	116	Undifferentiated	Winchell, A.N.	Greenback Mine, Josephine County
BASALT		HORNBLENDE-HYPERSTHENE		
Basalt*	21	Auvergnose, Feldspar, hornblende	Diller-Clarke	Cedar Creek 1½ mile NE of Ophir
Basalt*	21	Hypersthene beerbachose	Diller-Clarke	1 mile east of summit of Cascade Range on road from Fort Klamath to Crater Lake.
Basalt*	21	Hypersthene, olivine, andose-beerbachose	Diller-Clarke	Anna Creek, Crater Lake
Basalt*	21	Beerbachose, plagioclase, pyroxene	Diller-Clarke	Near fork of West Bend trail, 2½ miles south of Johnston Crk.
Basalt*	21	Hypersthene-andesitic tonalose	Diller-Clarke	North of Desert Cove Crater Lake
Basalt*	21	Feldspar and pyroxene	Diller-Clarke	Sawtooth Rock
Basalt (augite)	53	Hypersthene	Fraser, D.M.	Oakridge-Cresent

TABLE I (cont.)

Basalt*	21	Olivine-hypersthene	Diller-Clarke	Mt. Thielson
		AUGITE		
Basalt*	92	Augite-hypersthene	Renick, B.C.	Malheur County
Basalt	112	Augite	Williams, H.	Newberry Crater
Basalt	19	Augite	Campbell, I.	McKenzie River
Basalt	112	Augite-olivine	Williams, H.	Newberry Crater
Basalt*	21	Andose: augite olivine	Diller-Clarke	Base of Red Cone, Crater Lake
		OLIVINE		
Basalt	92	Normal Olivine	Renick, B.C.	Malheur County
Basalt	85	Normal Olivine	Lindgren, W.	Blue Mts.
Basalt	26	Olivine	Diller, J.S.	Near McKenzie Fork
Basalt	63	Olivine	Handly, H.W.	Upper Ceriba near contact with The Dalles formation.
Basalt	55	Olivine	Fuller, R.E.	Steen's Mt. eastern scarp.
Basalt	50	Olivine	Fisk, H.N.	Grand Coulee, Wash.
Basalt	53	Olivine	Fraser, D.M.	Oakridge-Cresent

TABLE I (cont.)

Ophite	53	Olivine	Fraser, D.M.	Oakridge-Cresent
Basalt	76	Olivine	Hoffman, M.G.	Moses Coulee, Wash.
Basalt*	18	Olivine	Callaghan, E.	Cupola Rock, Lost Creek, Lane County
Basalt*	47	Olivine, basic Silica low	Emmons, A.B.	Mt. Pitt
Basalt	48	Coriba type	Fisk, H.N.	North central Oregon
		OLIVINE FREE		
Basalt porphyry	1	Olivine free	Allen, J.E.	Columbia Gorge
Augite Basalt	1	Olivine free Pyriboles 20%	Allen, J.E.	Columbia Gorge
Augite Ophite	1	Olivine free	Allen, J.E.	Columbia Gorge
Basalt	92	Olivine free	Renick, B.C.	Malheur County
Basalt vitrophyre	1	Olivine free Plagioclase 40-60%	Allen, J.E.	Columbia Gorge
Basalt, Eocene	17	Quartz	Calkins, F.C.	Cherry Creek
		ANDESENE-LABRADORITE		
Basalt*	112	Aphyric	Williams, H.	Flow at base of Paulina Cliffs.
Basalt	53	Labradorite	Fraser, D.M.	Oakridge, Oregon

TABLE I (cont.)

Basalt*	8	Labradorite-andesene	Bogue, R.G.	Columbia, Coriba
Basalt	101	Andesene	Sheets, M.M.	Mt. Hood
Basalt	47	Porphyritic-andesite	Fisk, H.N.	Rogue River Valley
		UNDIFFERENTIATED		
Basalt	13	Undifferentiated	Butler & Mitchell	Curry County
Basalt, Cretaceous	13	Plagioclase Pyroxene	Butler & Mitchell	Horse-sign Butte, Curry County
Basalt*	18	Ophitic	Callaghan, E.	Lairds Ranch, Modoc Area, Cal.
Basalt*	18	Undifferentiated	Callaghan, E.	Steen's Mountain
Basalt	7	Undifferentiated	Barnes & Butler	Columbia Gorge
Basalt	15	Undifferentiated	Buwalda, J.P.	Snake River Valley
Basalt	17	Semi Ophitic	Calkins, F.C.	Antelope
Basalt	17	Glassy	Calkins, F.C.	The Dalles
Basalt*	18	Undifferentiated	Callaghan, E.	The Dalles
Yakima Basalt*	18	Undifferentiated	Callaghan, E.	Calaum Ridge, Wash.

TABLE I (cont.)

Basalt	2	Undifferentiated	Anderson, F.M.	West of Talant
Basalt, Eocene	29	Undifferentiated	Diller, J.S.	Coos Bay
Basalt*	112	Undifferentiated	Williams, H.	Flow on lava top Butte
Basalt*	112	Undifferentiated	Williams, H.	Double Falls of Paulina Creek
Basalt*	32	Undifferentiated	Diller & Patton	Crater Lake
Basalt	38	Undifferentiated	Diller, J.S.	Riddle Quadrangle
Basalt	117	Undifferentiated	Zimmerman, D.Z.	Long Tom Area
Basalt	108	Undifferentiated	Tuck, R.	Blue River Mining region.
Bastite	28	Weathered saxonite	Diller, J.S.	Riddle Quadrangle

DACITE

Dacite porphyry	21	Lassenose	Diller-Clarke	Sec.5-T-30-S-R-6-W
Dacite, porphyry*	21	Kallerudose Plagioclase Quartz	Diller-Clarke	6 miles west of big bend of Rogue River
Dacite porphyry*	21	Yellowstonose Quartz, Feldspar	Diller-Clarke	Head of Boulder Creek

TABLE I (cont.)

Dacite porphyry*	21	Alsbachose-lassenose	Diller-Clarke	South slope of Bald Mt.
Dacite porphyry*	18	Augite	Callaghan, E.	Bohemia District
Dacite	116	Plagioclase, Quartz	Winchell, A.N.	Galice district
Dacite porphyry	33	Feldspar, Quartz	Diller, J.S.	Grants Pass Quadrangle
Dacite	85	Quartz, Feldspar	Lindgren, W.	Blue Mts.
Dacite	87	Andesitic	Lindgren, W.	Nampa Quadrangle
Dacite Porphyry	117	Undifferentiated	Zimmerman, D.Z.	Long Tom Area
Dacite porphyry	26	Undifferentiated	Diller, J.S.	Calapooya Mt., Bohemia
Dacite*	32	Undifferentiated	Diller & Patton	Crater Lake
Dacite porphyry	13	Undifferentiated	Butler & Mitchell	Curry County
Rhyodacite*	116	Undifferentiated	Winchell, A.N.	Oriole Mine, Josephine County
Dacite, porphyry	116	Undifferentiated	Winchell, A.N.	Almeda Mine, Josephine County
Dacite porphyry	79	Undifferentiated	Kay, G.F.	Nickel Mt.

TABLE I (cont.)

DIABASE				
Diabase	19	Undifferentiated	Campbell, I.	McKenzie River
Diabase	29	Undifferentiated	Diller, J.S.	Coos Bay
Diabase	53	Olivine	Fraser, D.M.	Oakridge-Cresent
Diabase	40	Pyroxene	Diller, J.S.	20 miles west of Albany
Diabase	92	Pyroxene, Plagioclase	Parks, H.M.	6 miles north of Will-amina
Diabase	117	Quartz	Zimmerman, D.Z.	Long Tom Area
Diabase	85	Augite, Labra-dorite	Lindgren, W.	Blue Mts.
Diabase,Hornblende	1	Andesene 50% olivine free	Allen, J.E.	Columbia Gorge
Diabase	39	Undifferentiated	Diller, J.S.	Roseburg Quadrangle

DIORITE				
Diorite	65	Quartz, mica	Hershey, O.H.	Klamath Mts.
Diorite	62	Quartz	Goodspeed, G.E.	Cornucopia
Diorite	38	Quartz	Diller, J.S.	Riddle Quadrangle

TABLE I (cont.)

Diorite	85	Andesene-Labradorite, Feldspar	Lindgren, W.	Blue Mts.
Diorite*	18	Augite	Callaghan, E.	Bohemia district
Syenite porphyry	13	Undifferentiated	Butler & Mitchell	Curry Co.
Diorite	117	Undifferentiated	Zimmerman, D.Z.	Long Tom Area
Diorite	13	Undifferentiated	Butler & Mitchell	Curry County
Diorite	112	Undifferentiated	Williams, H.	Newberry Crater
DOLERITE				
Dolerite	53	Olivine	Frazer, D.M.	Oakridge-Cresent
Dunite	28	Weathered Saxonite	Diller, J.S.	Roseburg Quadrangle
FELSITE				
Felsite	114	Undifferentiated	Wilkinson, D.W.	Mutton Mts.

TABLE I (cont.)

GABBRO				
Gabbro*	21	Yellowstonose Quartz, Feldspar	Diller-Clarke	Brush Creek 1½ miles SW of Bald Mt., Port Orford
Gabbro*	21	Kilauase Pyroxene	Diller-Clarke	West of Brush Creek, near summit of Mussel Creek divide
Gabbro*	21	Monzonose Plagioclase, Hornblende	Diller-Clarke	Left bank of Rogue River, 2 miles below mouth of Illinoise River.
Gabbro, Pre-Jurassic	58	Undifferentiated	Gilluly, J.	Belt from Snake River to Canyonville
Gabbro	112	Undifferentiated	William, H.	Newberry Crater
Gabbro*	172	Undifferentiated	Williams, H.	South shore of East Lake near resort.
Gabbro*	116	Undifferentiated	Winchell, A.N.	Southwestern Oregon
Gabbro	117	Undifferentiated	Zimmerman, D.Z.	Long Tom Area

METAGABBRO				
Metagabbro	21	Hornblende Hessose	Diller-Clarke	Southeast slope of Panther Mt., Port Orford

TABLE I (cont.)

Metagabbro, Normal	21	Auvergnose	Diller-Clarke	Summit of Bald Mt. Port Orford
Metagabbro	39	Undifferentiated	Diller, J.S.	Roseburg, Quadrangle
GENTHITE				
Genthite	30	Nickel silicate	Diller, J.S.	Directly west of Riddle
GRANITE				
Granite	85	Normal soda	Lindgren, W.	Blue Mt. Mining region
Granite	59	Albite	Gilluly, J.	Sparta
Granite	14	Undifferentiated	Buwalda, J.P.	Blue Mts.
Granite-porphyry	17	Undifferentiated	Calkins, F.C.	Spanish Gulch
Granite	19	Undifferentiated	Campbell, I.	McKenzie River
Granite	95	Undifferentiated	Rickard, T.A.	Cornucopia
Granite*	116	Undifferentiated	Winchell, A.N.	White Point, Jackson County

TABLE I (cont.)

Granite	65	Undifferentiated	Hershey, O.H.	Klamath Mts.
GRANODIORITE				
Granodiorite*	21	Hessose	Diller-Clarke	Sec.26-T-30-S-R-3-W
Granodiorite*	21	Yellowstonose Quartz, Hornblende Andesene	Lindgren-Clarke	Base of Bald Mt. NW of Sumpter
Granodiorite	33	Plagioclase, Quartz, Hornblende	Diller, J.S.	Grants Pass Quadrangle
Granodiorite	60	Plagioclase, Quartz	Gòòdspeed, G.E.	Cornucopia
Granodiorite	85	Acid	Lindgren, W.	Blue Mts.
Granodiorite	105	Undifferentiated	Smith, W.D.	Wallowa Mts.
Granodiorite, porphyry*	18	Augite-hypersthene	Callaghan, E.	Bohemia district
Granodiorite*	18	Hornblende-Augite	Callaghan, E.	Behemia district.
Granodiorite*	18	Hornblende-biotite	Callaghan, E.	Snoqualmie Batholith Wash.
Granodiorite	17	Undifferentiated	Calkins, F.C.	Middle Fork John Day River.

TABLE I (cont.)

Granodiorite	117	Undifferentiated	Westgate, L.G.	Elkhorne Range north of Sumpter.
GREENSTONE				
Greenstone	13	Undifferentiated	Butler & Mitchell	Curry County
Greenstone*	21	Near granodiorite Vaalose	Diller-Clarke	Evans Creek near mouth of Sykes Creek, Riddle Quadrangle
Greenstone*	21	Diabasic Beerbachose	Diller-Clarke	S 2T-30-S-R-6-W
Greenstone*	21	Basaltic	Diller-Clarke	S 23-T-31-S-R-6-W
Greenstone*	21	Gabbroic	Diller-Clarke	S 2-T-34-S-R-6-W
Green stone*	21	Dioritic oneose	Diller-Clarke	29-T-34-S-R-6-W
Greenstone	33	Pyroxene, Felds-par	Diller, J.S.	Grants Pass Quadrangle
Greenstone	53	Undifferentiated	Gilluly, J.	Belt from Snake river to Canyon City
Greenstone	79	Pyroxene, Felds-par	Kay, G.F.	Nickel Mt.

TABLE I (cont.)

Greenstone, Paleozoic	85	Altered	Lindgren, W.L.	Blue Mts. Mining region
Greenstone	105	Undifferentiated	Smith, W.D.	Wallowa Mts.
Greenstone*	116	Undifferentiated	Winchell, A.N.	Harth & Ryan mine, Jackson Co.
Harzburgite	79	Nickeliferous	Kay, G.F.	Nickel Mt.
Hornblendite	116	Quartz, Calcite Pyroxene	Winchell, A.N.	Little Pittsburg mine, Ashland district.
Keratophyre	66	Undifferentiated	Hodge, E.T	Mt. Jefferson
Kersantite	85	Dioritic	Lindgren, W.	Blue Mts.
Kersantite	111	Quartz, Hornblende	Waters, A.C.	Corblay Canyon, Wash.
Kersantite	117	Undifferentiated	Winchell, A.N.	Jackson County
Laurvikite	66	Olivine	Hodge, E.T.	Mt. Jefferson
Lithoidite	114	Undifferentiated	Wilkinson, D.W.	Mutton Mts.
Malchite	116	Sodic Plagioclase	Winchell, A.N.	Ashland Mine, Jackson County
Quartz Monzonite	108	Undifferentiated	Tuck, R.	Blue River Mining Region
Quartz Monzonite	19	Undifferentiated	Campbell, I.	McKenzie River
Mugearite	66	Undifferentiated	Hodge, E.T.	Mt. Jefferson

TABLE I (cont.)

Nevadite	112	Undifferentiated	Wilkinson, D.W.	Mutton Mts.
Norite	116	Pyroxene, plagioclase	Winchell, A.N.	Chisholms Copper Mine, Jackson County
Obsidian	43	Acid	Dutton, C.E.	McKenzie Pass
Obsidian	112	Massive	Williams, H.	Newberry Crater Black flow on north wall of Crater
Glass	114	Undifferentiated	Wilkinson, D.W.	Mutton Mts.
Vitrophyre	1	Pyroxene 25% Plagioclase 25% Augite	Allen, J.E.	Columbia Gorge
Vitrophyre	53	Basic	Fraser, D.M.	Oakridge-Cresent
Oligoclasite	66	Olivine	Hodge, E.T.	Mt. Jefferson
Orthophyre	114	Undifferentiated	Wilkinson, D.W.	Mutton Mts.
Pantellerite	114	Undifferentiated	Wilkinson, D.W.	Mutton Mts.
Pegmatite	85	Orthoclase & Microcline	Lindgren, W.	Blue, Mts.
Peridotite*	13	Undifferentiated	Butler & Mitchell	Curry County
Peridotite*	21	Saxonite	Diller-Clarke	Riddle Quadrangle
Peridotite	28	Chromiferous	Diller, J.S.	Klamath Mts.

TABLE I (cont.)

Pyroxenite	116	Magnetite	Winchell, A.N.	Whitney Mine, Gold Hill, Oregon
Pyroxenite	17	Und.	Calkins, F.C.	Spanish Gulch Beach Creek

RHYOLITES

Rhyolites, Eocene	17	Spherulitic Anorthoclase bearing	Calkins, F.C.	Current Creek Hill
Rhyolite, Miocene	17	Spherulitic Anorthoclase bearing.	Calkins, F.C.	John Day
Rhyolite Vitrophyric*	21	Plagioclase Hypersthene Lassenose	Diller-Clarke	Llao Rock, Crater Lake
Rhyolite*	21	Lassenose	Diller-Clarke	Wine Glass Crater Lake
Rhyolite*	21	Lassenose	Diller-Clarke	Dike below Llao Rock Crater Lake
Rhyolite*	21	Lassenose	Diller-Clarke	Head of Cleetwood Cove Crater Lake
Rhyolite, porphyritic	92	Plagioclase, augite	Renick, B.C.	Malheur County

TABLE I (cont.)

Rhyolite	85	Lithoidal	Lindgren, W.	Blue Mts.
Rhyolite	87	Feldsitic	Lindgren, W.	Nampa Quadrangle
Rhyolite	112	Glassy	Williams, H.	Newberry Crater
Rhyolite*	112	Platy	Williams, H.	1 mile south of East lake resort.
Rhyolite*	112	Platy	Williams, H.	Summit Paulina Peak
Rhyolite	13	Und.	Butler & Mitchell	Curry County
Rholite	14	Und.	Buwalda, J.P.	Hay Creek, John Day
Rhyolite, Eocene	15	Undifferentiated	Buwalda, J.P.	Snake River Valley
Rhyolite-	26	Und.	Diller, J.S.	Near McKenzie Fork Blue River Region
Rhyolite	39	Und.	Diller, J.S.	Roseburg Quadrangle
Rhyolite	19	Und.	Campbell, I.	McKenzie River
Rhyolite	114	Und.	Wilkinson, D.W.	Mutton Mts.
Santorinite	117	Olivine	Zimmerman, D.Z.	Long Tom Area

TABLE I (cont.)

Saxonite	79	Nickeliferous	Kay, G.F.	Nickel Mt., Ore.
Saxonite	28	Nickeliferous	Diller, J.S.	3 miles west of Riddle Nickel Mt.
Serpentine*	21	Pyroxene, Olivine	Diller, J.S.	Iron Mt. Crest, Port Orford
Serpentine	116	Diorite	Winchell, A.N.	Marshall Mine, Galice district.
Serpentine	17	Undifferentiated	Calkins, F.C.	Beach Creek
Serpentine*	21	Undifferentiated	Diller-Clarke	12 miles north of Boulder Creek Port Orford Quadrangle
Serpentine	33	Undifferentiated	Diller, J.S.	Grants Pass Quadrangle
Serpentine	85	Undifferentiated	Lindgren, W.	Blue Mts.
Spessartite*	116	Undifferentiated	Winchell, A.N.	Jacksonville Quarry, Ore.
Spessartite*	116	Undifferentiated	Winchell, A.N.	Braden Mine, Jackson, Ore.
Tonalite	80	Intrusive	Kellogg, A.E.	Applegate district

TABLE I (cont.)

Tonalite*	116	Und.	Winchell, A.N.	Wilderville, Josephine County
Tonalite*	116	Und.	Winchell, A.N.	Umpqua River
Trachyte	114	Undifferentiated	Wilkinson, D.W.	Mutton Mts.

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